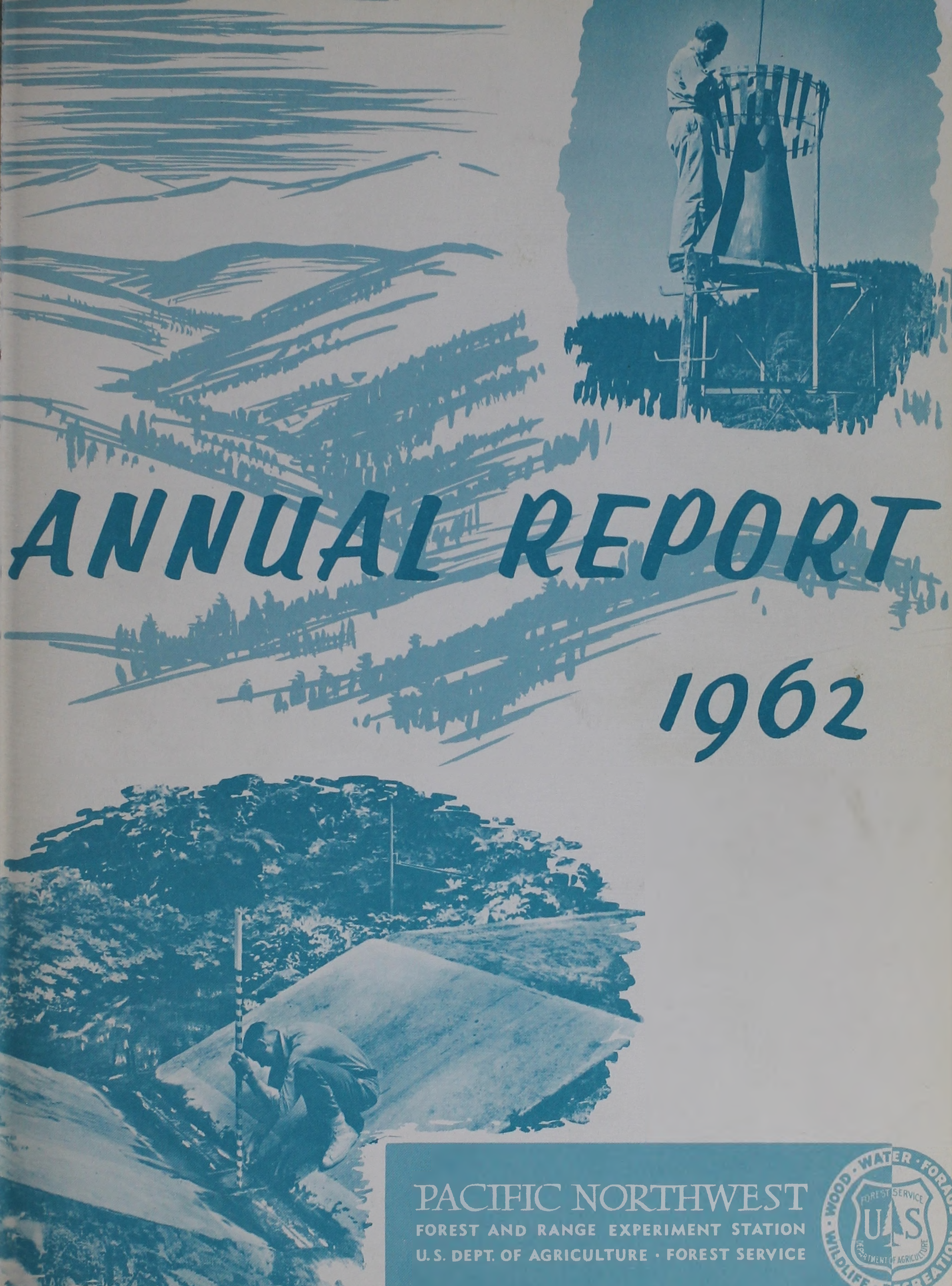

ANNUAL REPORT

1962

PACIFIC NORTHWEST
FOREST AND RANGE EXPERIMENT STATION
U. S. DEPT. OF AGRICULTURE · FOREST SERVICE

Foreword

Most manifest progress during 1962 was in development of new research facilities. Increased program funds for FY 1963 were relatively small and, with one exception, did not provide for new projects. New financing enabled us to initiate a program of forest engineering research with its first study directed towards the feasibility of helicopter logging. Other increases in program funds were used to strengthen current projects in forest management, watershed management, wildlife habitat, forest fire, forest disease, and forest insect research.

Contracts were awarded in early summer for construction of a Forest Hydrology Laboratory at Wenatchee, Wash., and a Silviculture Laboratory at Bend, Oreg., and by the end of the year construction was well along. During the year, a utility building, house trailer site, and other improvements were completed at the Starkey Experimental Forest and Range near La Grande, Oreg.

Funds made available through the Accelerated Public Works Program enabled us to plan and accept bids for construction of greenhouses, site improvement, and landscaping at Roseburg, Oreg., and Wenatchee. Contracts will be awarded early in 1963.

The Forestry Sciences Laboratory at Corvallis, Oreg., was dedicated in August with appropriate ceremonies. All offices and laboratory units are occupied and functioning well. We are still adding needed scientific equipment. An exhibit of research at Corvallis was the first of similar public displays to be installed in other Station units.

Relations with other research institutions were strengthened, and a total of five cooperative research projects were entered into with Oregon State University and University of Washington. The Station has continued to benefit from the counsel of its advisory committees and the advice and cooperation of many other groups and individuals.

This year, we are reporting progress on a project basis in keeping with our reoriented organization structure. This Station has been assigned 39 projects; 19 of these are or will be headquartered in Portland, 1 in Bend, 9 in Corvallis, 2 in La Grande, 2 in Roseburg, 2 in Olympia,

1 in Wenatchee, and 3 in Seattle. Each project has a research scientist designated as the project leader. Projects are grouped under the appropriate division. Project leaders are responsible administratively to their division chief. At this time 34 of the 39 projects are activated.

It is hoped that other innovations in the content and format of the report, including brevity, will better meet the needs of our audience. We would appreciate your comments.

R. W. Coulin

February 1963

ANNUAL REPORT

1962

PACIFIC NORTHWEST
FOREST AND RANGE EXPERIMENT STATION
R. W. Cowlin, Director
Portland, Oregon

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

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Watershed Management Research

E. G. DUNFORD, Division Chief

WATERSHED LOGGING METHODS AND STREAMFLOW REGULATION

Jack Rothacher, project leader, Nedavia Bethlahmy,
C. T. Dyrness, and Richard Fredriksen

Research in this project, centered at Corvallis, Oreg., includes studies of logging methods, road construction, and timber management practices to determine how they influence the characteristics and interrelations of soil, plants, and water. The ultimate objective is to develop guidelines for control of erosion and regulation of streamflow in the Douglas-fir and associated forest types west of the Cascade Range. Field investigations are underway at H. J. Andrews Experimental Forest in the McKenzie River drainage and in the Bull Run watershed, a drainage west of Mount Hood supplying water for the City of Portland. Recently, our program expanded into southwest Oregon where we now have two experimental watersheds in South Umpqua Experimental Forest.

Watershed Logging Studies

At H. J. Andrews Experimental Forest we began logging this fall on two experimental watersheds (237 and 250 acres). The study is designed to give information on how removal of all or part of the timber will influence total annual streamflow, high flows during the winter, minimum flows in summer, and temperature and sediment content of the stream.

A Wyssen Skyline-Crane is being used to remove all timber from one of the watersheds. No roads within the drainage are needed with this system, and, because logs are lifted clear of the ground and travel along a cable to a landing, a minimum of soil disturbance is expected.

Wyssen Skyline-Crane. Yarder is in foreground and loader in middle distance.

On the second watershed, a high-lead system with necessary access roads is being used to remove 25 percent of the timber. In contrast to the Skyline-Crane operation, cables which drag logs to the landing give only partial lift to the logs.

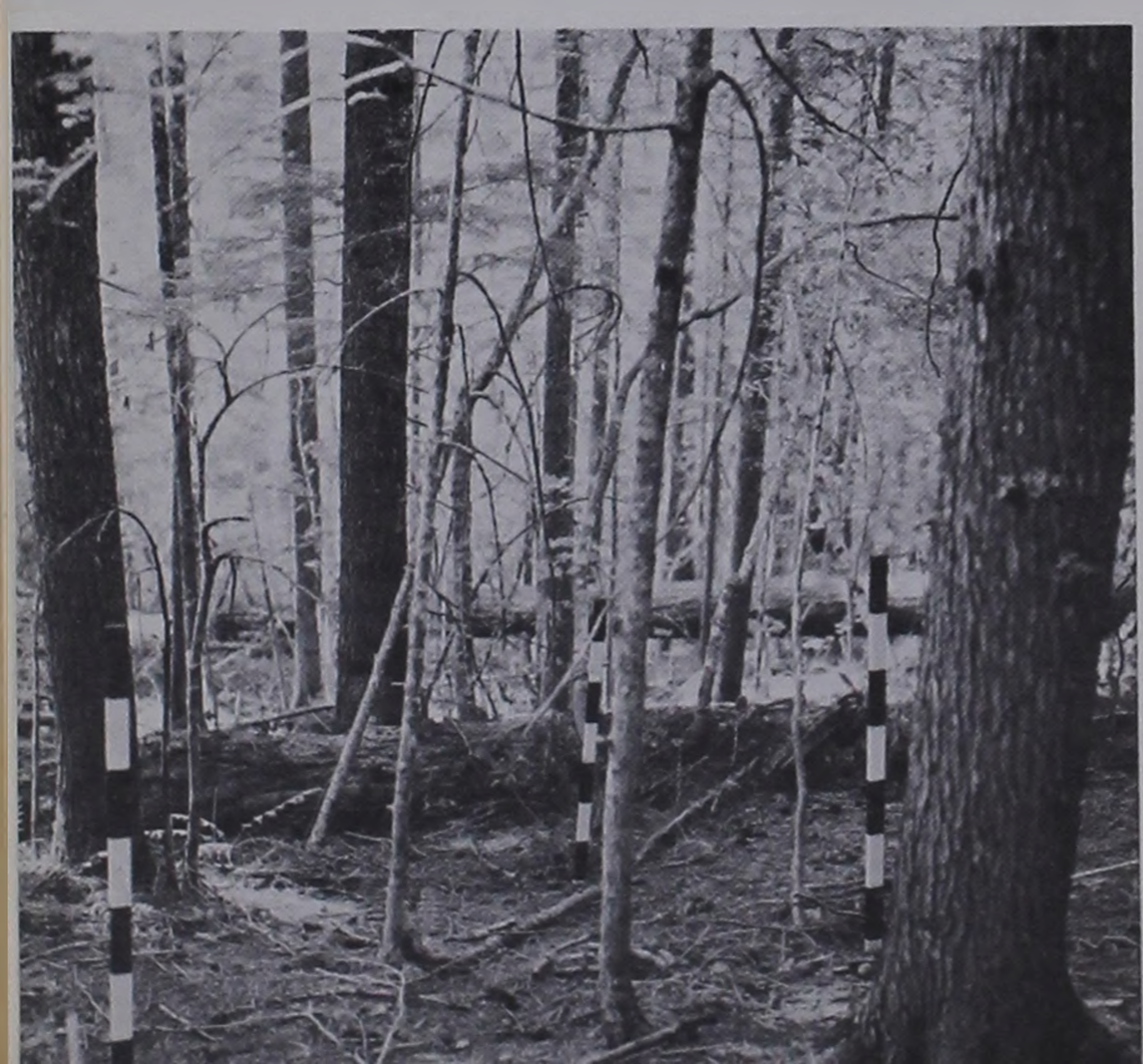
Several studies are in progress to appraise and compare the changes that result from these logging methods.

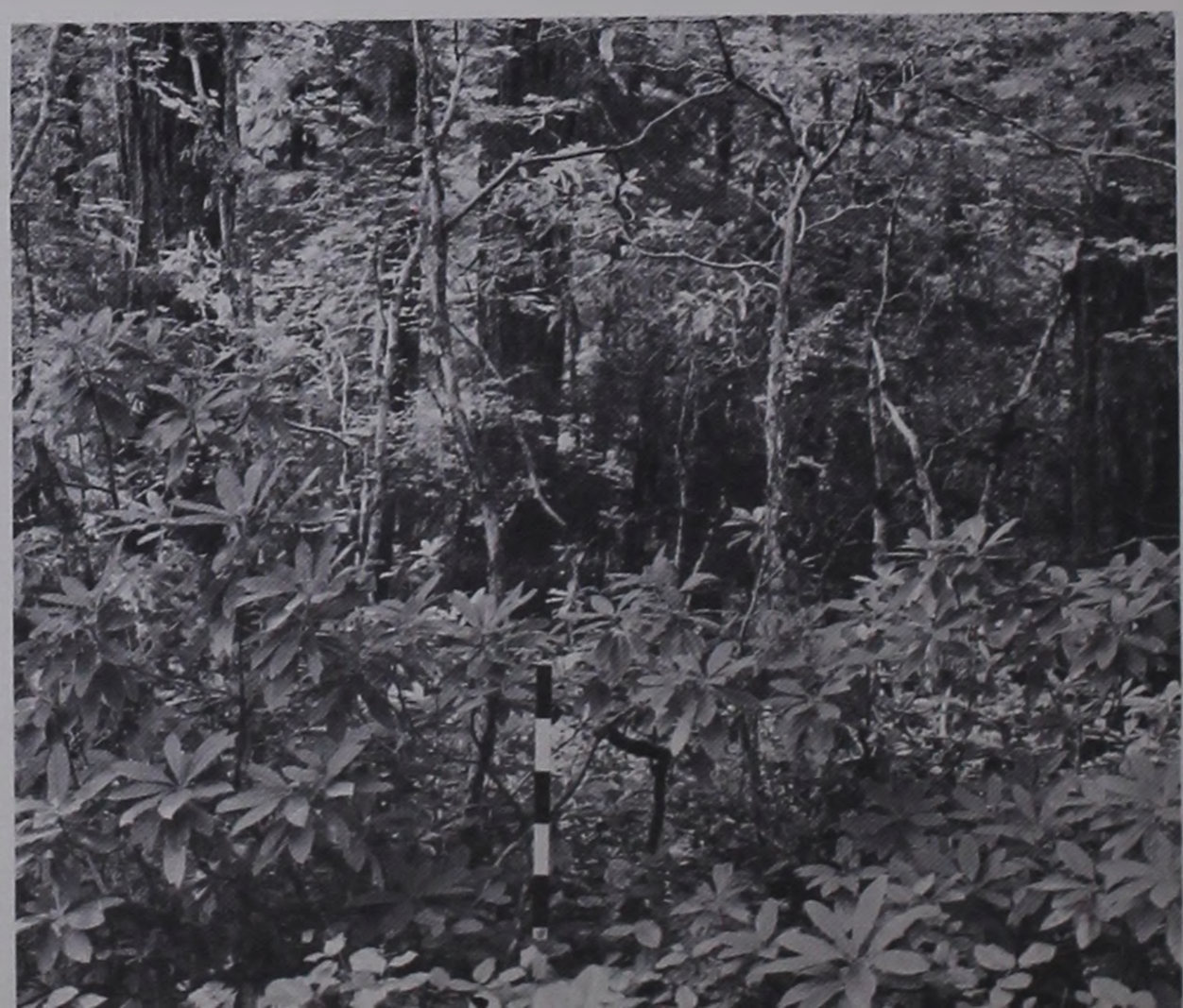
Logging heavy timber from steep slopes unavoidably creates some soil disturbance. We hope to evaluate this effect by sampling surface soil conditions after completion of logging by the high-lead and Skyline-Crane systems. The purpose is to compare area and severity of soil disturbance in four classes ranging from light to severe and compacted. Samples already taken from undisturbed areas in the watersheds show surface soil to be extremely porous.

Another study is designed to trace changes in understory vegetation caused by timber cutting. Permanent milacre sampling plots have been established, and on each watershed we have described the vegetation before cutting began. On one watershed, six distinct understory plant communities have been identified. They range from a hazel-salal type, occurring on the driest sites, to the swordfern type on very moist sites along stream channels and north-facing slopes.

For a year or two after timber is logged and slash is burned to reduce fire hazard, little vegetation remains to use water held in the soil. Successional trends following logging and slash burning will be studied to determine how soil stability and streamflow are influenced by the change from deep-rooted trees to shallow-rooted annuals and, finally, back to second-growth forests.

Permanent sample plots for following vegetative trends in experimental watersheds. Two contrasting habitat types are shown: gold thread on the left and rhododendron-salal on the right.





Two transects of soil-moisture measuring stations under old-growth Douglas-fir have been studied for several years. The trees will be logged from one transect of plots. Further study of changes in soil moisture in the two transects will provide added information on how forest cover influences water movement and water storage in the soil, and ultimately, how these are correlated with streamflow.

Meter for determining moisture in soil by measuring resistance to an electric current.

Water Chemistry

Chemicals contained in forest litter and debris resulting from logging are released as the organic compounds are broken down by fire and by weathering. Soil may act as a filter and remove some of the chemicals dissolved by rainwater. The remainder will appear in streamflow. A preliminary study has been started to measure the quantity of chemicals reaching the stream and their effect on the quality of the water.

Research Methods

During the past year, we have been experimenting to speed up some of the time-consuming processes in watershed management research. One promising improvement will appreciably reduce the time needed for comparing experimental watersheds before applying a treatment. It is based on a statistical analysis of individual storms and will speed up longterm watershed investigations concerned with streamflow. A second development is to use automatic data processing for the tedious computation of streamflow records. While the basic tool has been available for some time, its application has required some complicated programing procedures.

Plans for 1963

Major emphasis will be to evaluate effects of several methods of logging on soil erosion and sedimentation, water quality, the vegetational pattern, and streamflow at H. J. Andrews Experimental Forest. Road construction will begin on the study watersheds in the Bull Run area.

WATER YIELD AND EROSION

E. G. Dunford, acting project leader,
David D. Wooldridge, H. G. Herring, William Fowler,
William Lopushinsky

Watershed problems of eastern Oregon and Washington are the primary concern in this project centered at Wenatchee, Wash. Studies are directed toward two major objectives: to determine the influence of vegetation on streamflow so that we can manage watersheds for increased water yield and to learn more about forest soils to enable us to control erosion and rehabilitate depleted areas.

Neutron probe inserted into the soil detects presence of hydrogen, thus supplying an index to water content.

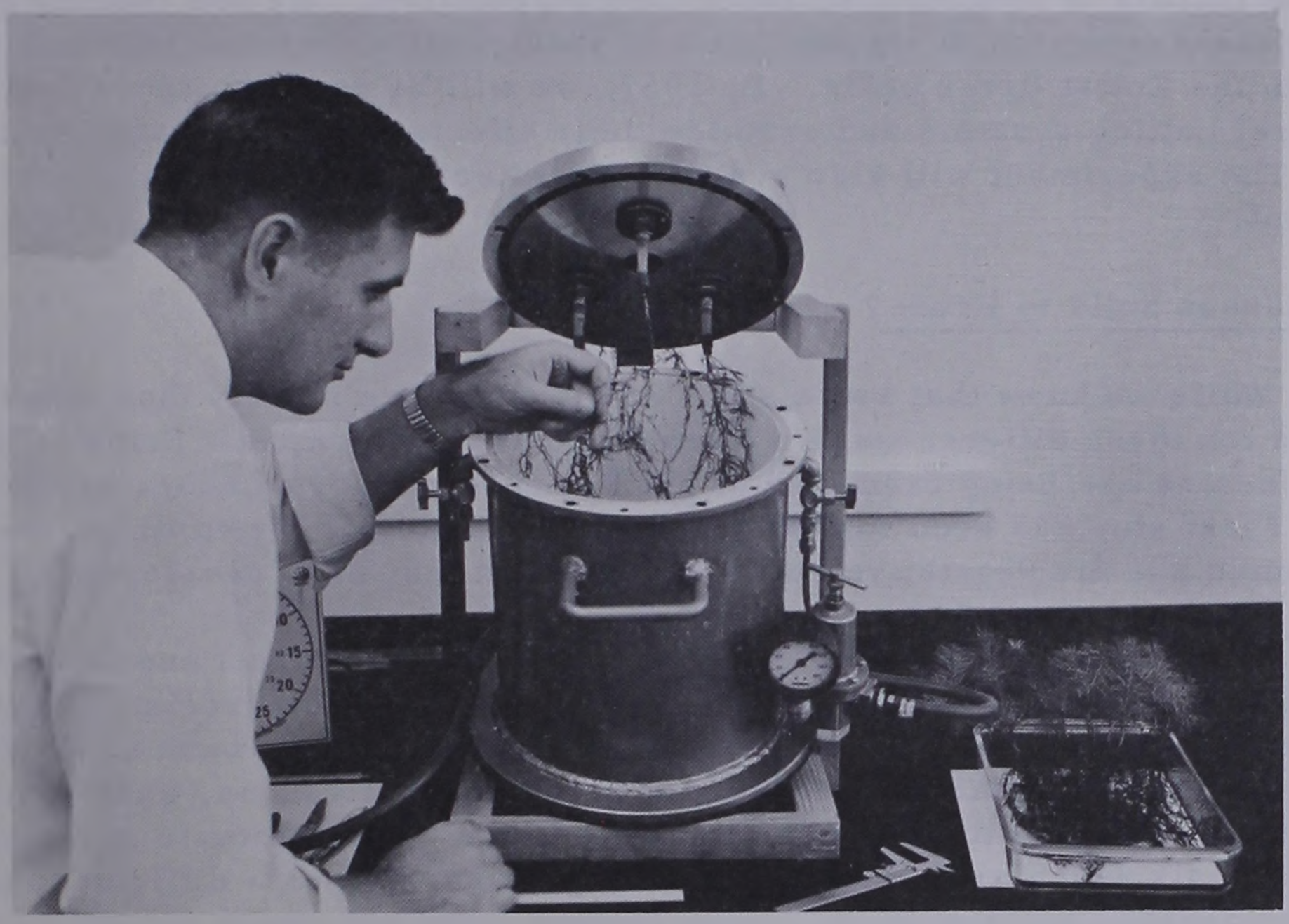
Use of Soil Moisture by Trees

We know very little about the use of soil moisture by tree species of eastern Washington and Oregon. During this past year, 24 plots were installed in young lodgepole pine stands, and a neutron soil-moisture probe is being used to follow the soil-moisture cycle on these plots. In 1964, some of these plots will be cleared and changes in pattern of soil-moisture use determined. Very precise studies of the microclimate will be carried out over eight of these plots to correlate soil-moisture use with climatic variables such as wind movement, temperature, humidity, and net radiation.

During the past few months, a study has been started to learn more about water permeability of roots of various tree species. Using a pressure chamber, water movement through tree roots can be measured under laboratory conditions. Information from such studies will permit a better understanding of transpiration by vegetation on watersheds.

Energy and Water Use

Transpiration and evaporation are two important water users in a forest; together they account for most of the gap between precipitation and streamflow.



Pressure chamber used for studying movement of water through roots.

Both require energy which may be supplied by insolation, infrared radiation from cloud and sky, or by advected energy caused by horizontal movement of air within a watershed. While considerable information is available regarding energy used in evapotranspiration, application to our studies requires a measurement of energy input for given watershed areas.

We are making our first attempt to do this in the 2,800-square-mile Wenatchee River drainage. Of 14 continuously recording measuring stations being established, some are outside the drainage to evaluate the influence of the immediately surrounding area.

Our primary measuring device is the pyranometer, an instrument which measures the energy input received from the sun. We recognize that this network will not evaluate all influential factors in the radiative balance of an area. Still, a measure of shortwave radiation supplied by the pyranometer provides an index well correlated with net radiation and useful in following the constantly changing energy balance which affects evaporation and transpiration.

Experimental Watersheds

Experimental watersheds provide another and more familiar method of studying factors of evapotranspiration and streamflow. We are making continuous measurements of streamflow and precipitation on three matched watersheds in the Entiat River basin. By 1967, we will be ready to apply some silvicultural cutting systems and examine their effects on quantity and timing of flow. The experiment will also evaluate the effect of logging on erosion and sediment.

What Causes Soils to Erode?

While we know that some soils will erode more readily than others, the reasons for these differences are often difficult to determine. Some of the known factors are being examined at the Forest Hydrology Laboratory in Wenatchee. First step has been to look at the parent materials from which the soils are formed and the vegetative cover under which they have developed.

Three soil parent material types are of major interest and importance in central Washington because of their extensive area and associated land management problems. They are: basalts, granodiorite, and Swauk sandstone. Soils formed from basalt have a reputation for productiveness, ease of management, and resistance to processes of soil erosion. Granodiorite parent materials form soils which are, in general, less productive, more difficult to manage, and considerably more erosive. Soils formed from the Swauk sandstone formation in this region rank highest in difficulty of management and soil erosion hazard. Under certain conditions, however, soils formed from sandstones are stable and quite productive of both timber and forage crops.

We examined properties of soils formed from these three parent materials, selecting samples from areas having two classes of cover: forest and grass. The main value of the study, so far, has been to identify soil properties with soil erosion hazard, rather than to develop soil erosion hazard prediction equations.

Plans for 1963

The new Forest Soil and Hydrology Laboratory at Wenatchee, Wash., will be ready for use by late spring, enabling us to step up our studies of soil characteristics and tree-root permeability. In the field, we plan to give increased attention to snowpack management, starting with a reconnaissance

of snow accumulation areas on the east slopes of the Cascade Range in Washington. A complete microclimatological station will be set up at a high elevation for studies of the energy budget over a lodgepole pine forest and for determination of the climatic factors relating to accumulation, storage, and melting of snow.

Forest Disease Research

T. W. CHILDS, Division Chief

FOREST DISEASE CONTROL

T. W. Childs, acting project leader,
Paul E. Aho, James W. Edgren, Thomas H. Laurent

This project includes activity on several diseases, but most of our effort during the last 3 years has been on heart rots of true firs and associated species in upper-slope forest types and on ponderosa pine dwarfmistletoe.

Heart Rots of True Firs and Associated Species

The high percentage of defect characteristic of old-growth white firs is one of the big obstacles to good management of more than 4 million acres of commercial forest land other than the Douglas-fir and ponderosa pine types in Washington and Oregon. Actual control of heart rots, in the strict sense of the word, is not possible in defective, old stands. Nevertheless, in harvesting these stands, waste can be substantially reduced if volume and extent of decay columns in individual trees can be estimated more accurately in standing timber.

A dissected white fir, badly decayed by the Indian-paint fungus.

In the first stage of a study for the purpose of improving such estimates, detailed data were taken on extent of decay and its association with external indicators in 567 white firs and 552 trees of other species dissected in the Blue Mountains of southeastern Washington and northeastern Oregon. These dissected trees include all the sawtimber and most of the large poles on forty 1/10-acre plots in five localities. An intensive cruise was made of 61 additional plots on which the trees were not dissected.

Since this basis is too small to yield results of acceptable accuracy, work will be continued in the Blue Mountains for another year or so.

Impact of Dwarfmistletoe on Ponderosa Pine Yields

Ponderosa pine dwarfmistletoe can be controlled by local sanitation. However, to determine where control is economic by present methods, and where it must be postponed until costs are lowered, we need better measurements than are now available of dwarfmistletoe's effect on growth and mortality of its host. Good data on these points will eventually be available from permanent study plots, but information is needed now.

For immediate needs, we have taken detailed data, including radial growth measured along increment cores, on 2,340 ponderosa pines on 34 acres of scattered plots (mostly 1/10-acre) in 4 localities on the Deschutes and Fremont National Forests. Trees ranged in size from large saplings to young sawtimber and included 112 trees dissected for a study of dwarfmistletoe effect on form and on height growth. Basal area and mortality data were also taken on 107 additional 1/10-acre plots in 2 of the localities. Most of the plots were site III or IV.

Dwarfmistletoe impact study area in young sawtimber stand. Note brooming of lower crowns.

Plans for 1963

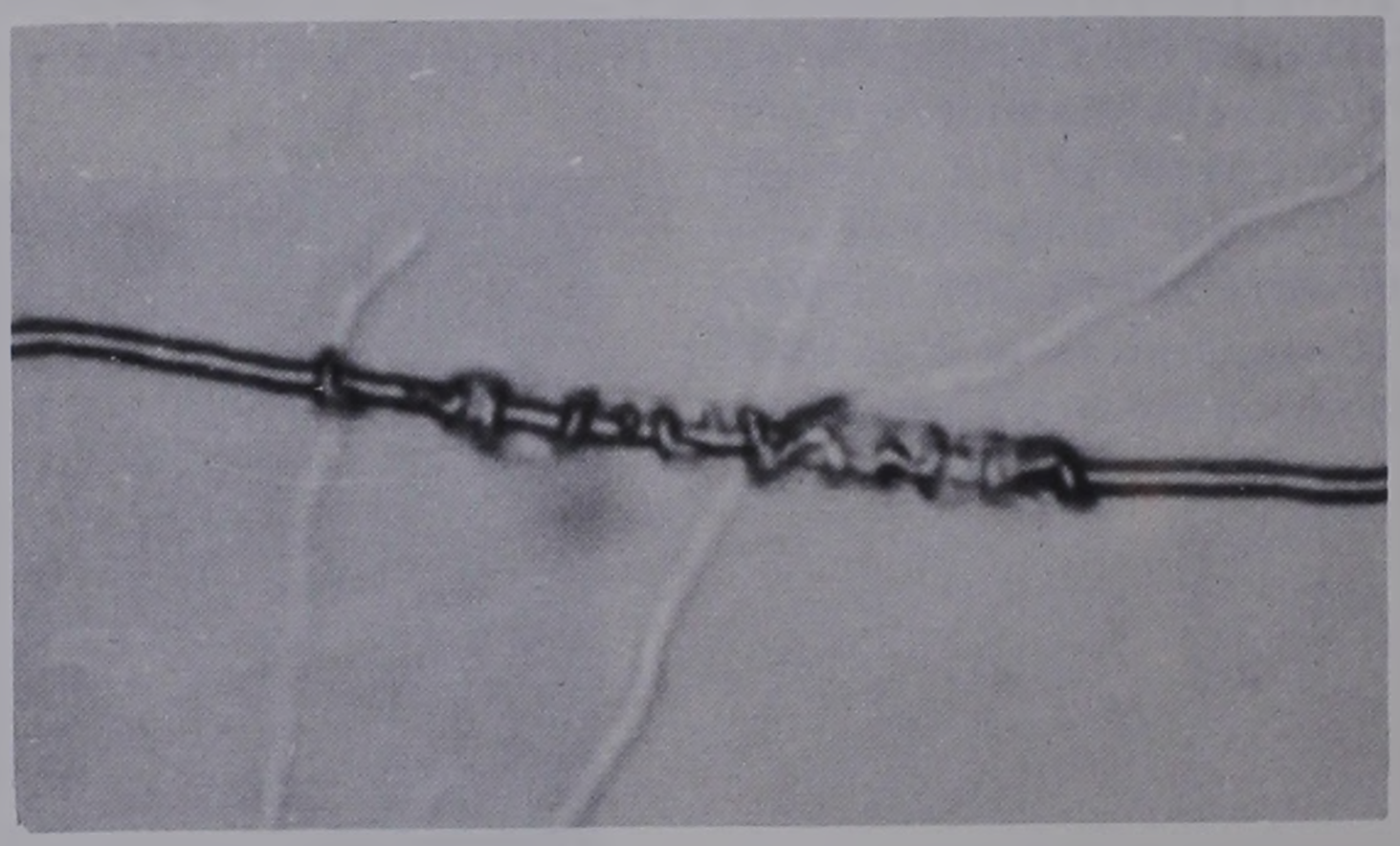
In the study of heart rots of true firs and associated species, we will finish the analyses of data already obtained, get the preliminary results into use, and continue field work in the Blue Mountains.

In our analysis of the impact of dwarfmistletoe on ponderosa pine, we plan to develop a program for automatic processing of the growth data, make results of the growth study available for use in economic analyses of control, and continue field studies of rates of pine mortality in young stands and of dwarfmistletoe intensification.

SOIL MICROBIOLOGY

Bratislav Zak, project leader, Kuo C. Lu

Soil micro-organisms play a large part in forest health, not only through their effect on tree nutrition but also through the effect of some of them in controlling root diseases. Although long studied by agricultural researchers, they have been given little attention by foresters. Work on this project is just beginning, and will be one of the principal disease research activities at the Corvallis laboratory.



Trichoderma *(light hyphae) parasitic on*
Poria weirii *(dark hypha).*

Since ability of pathogens to invade roots is probably affected strongly by micro-organisms on and near the root surface, it may be possible to get some measure of disease control by modifying rhizosphere environments to favor certain micro-organisms. But first we must learn what species of micro-organisms are present, their effect on pathogens, and their environmental requirements.

A study designed to get some of this information was started last year. The first phase will be restricted to the influence of soil nitrogen on micro-organism populations of Douglas-fir and western hemlock roots, and will be coordinated with an Oregon State University study of nitrogen fixation by the red alder root nodule bacterium. Another study, started in 1961, has yielded preliminary results on the effects of organic soil amendments on the abundance of certain soil fungi antagonistic to a nursery pathogen.

Plans for 1963

We will start general exploratory work on kinds, effects, and ecology of forest-soil micro-organisms.

FOREST ROOT DISEASES

T. W. Childs, acting project leader, E. E. Nelson

Recent work on this project has been concerned almost entirely with Poria weirii, a destructive pathogen of Douglas-fir and other conifers. Continuing studies of P. weirii clone distributions have strongly substantiated the conclusion that most infection centers originate from old infected roots of the preceding stand.

Length of survival of the fungus in underground dead material therefore seems likely to be of great importance in control of the disease. A preliminary study to determine the principal factors involved in such survival and to follow the process of infection from dead material into living, intact roots has indicated promising lines for further research.

While other root diseases are usually less damaging, experience elsewhere indicates that some of them will probably become more injurious under intensive management. Increased activity by Armillaria mellea, brought about by recent dry summers, emphasizes the need for effective measures of direct control to protect seed orchards and other stands of special value.

Ponderosa pine saplings killed by Armillaria.
Infection spread from stumps.

Plans for 1963

A basic research program for forest root diseases will be started at the Corvallis laboratory.

Tests of direct control methods will be started for protection of high-value individual trees.

NURSERY, PLANTATION, AND FOREST PRODUCTS DISEASES

George M. Harvey, project leader

Only a few small studies are in progress under this project. Efforts continue to develop an antibiotic treatment to protect white pine seedlings against blister rust for 2 or 3 years following planting--the period when infection is most difficult to prevent by usual methods.

Previous work has resulted in fairly good control of nursery diseases at Bend, Oreg., and Wind River, Wash., but studies have been continued at Bend to improve control methods.

Plans for 1963

A study of the molds that reduce viability of Abies seed will be started.

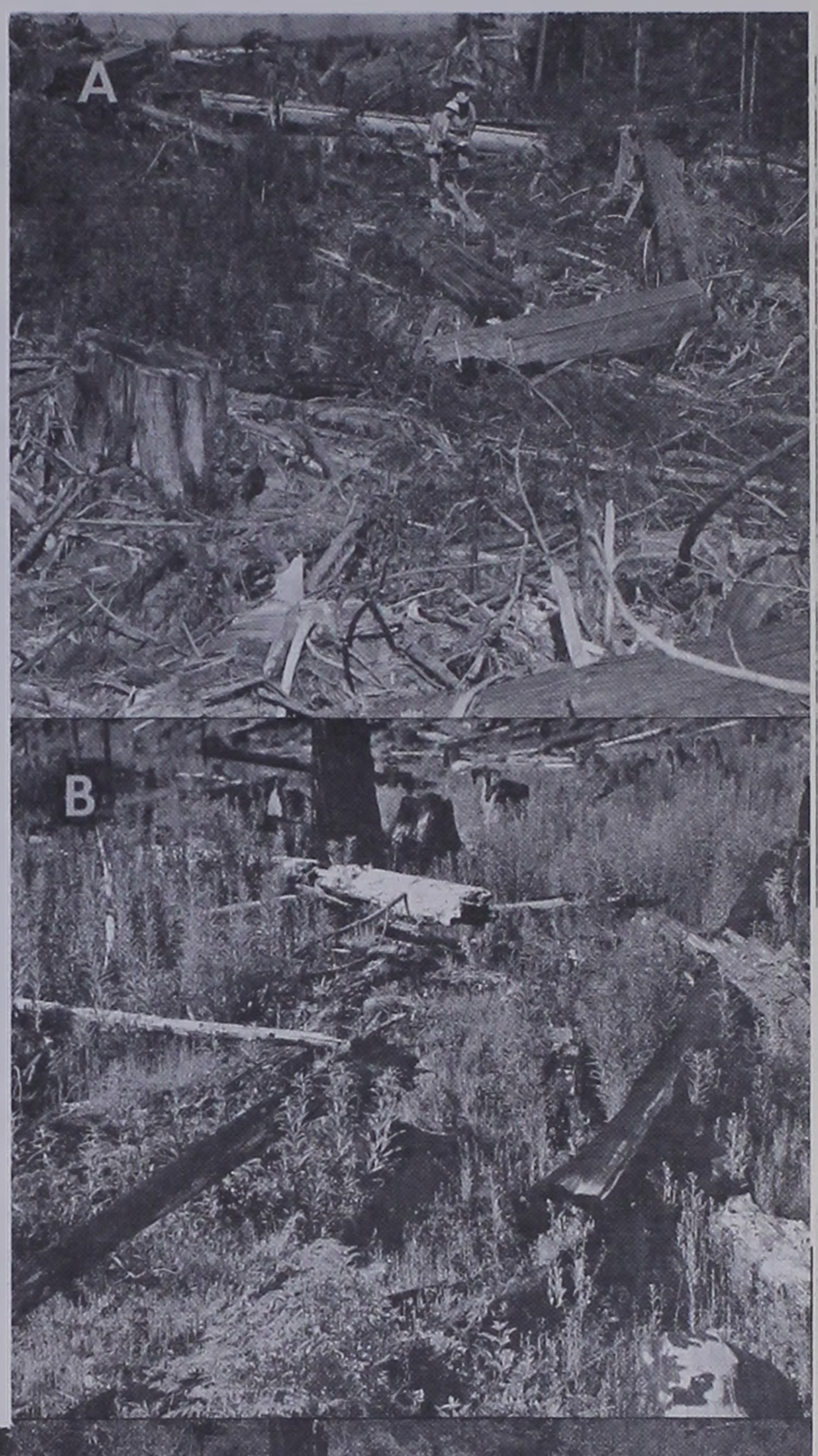
Forest Fire Research

DAVID BRUCE, Division Chief

FIRE CONTROL AND USE

William G. Morris, project leader, Harold K. Steen

From 1946 to 1952, we established 63 pairs of burned and unburned slash plots in many localities of the Douglas-fir region to determine the effect of slash burning on fire hazard, restocking by commercial tree species, and plant cover. Each year until 1953, we re-examined the plots to determine trends in these characteristics on burned and unburned slash



The second year after logging, one plot (A) was left unburned while the other (B) was burned. The third year after logging, much more fine slash remained on the unburned plot (A) than on the adjacent burned plot (B).

Although herbaceous plants partially hide the fine slash, much of it still remains on the unburned plot (C) 12 years after logging. Natural restocking on the burned plot (D) equals that on the unburned. On many other areas of this age, brush covers more of the ground whether burned or not. Located near McKenzie Bridge, Oregon.

areas. Research Paper 29 described those results. This year, Steen and a student assistant reexamined all plots. As before, there appeared to be no difference in average number of natural seedlings on burned and unburned pairs of plots.

Since slash moisture largely determines how slash will burn, Morris is testing methods of judging slash burning conditions.

To learn something of the factors causing variation in moisture content near the surface of logs in slash, a forestry aid measured daily moisture content with an electric resistance moisture meter at 1/8-, 1/4-, and 1/2-inch depths at some 60 sampling points on logs in current slash at Wind River from early summer to late fall. This also involved measuring temperature with a thermistor probe at the same depth as the resistance moisture meter pins. In addition, he recorded relative humidity, air temperature, and moisture content of standard and large fuel moisture indicator sticks.

After measuring moisture content of a log by electric resistance, the observer measures the wood temperature with a small thermistor probe.

At many sampling points, measurements gave consistent values and trends of moisture, but at other points moistures varied widely. General conclusions about surface moisture of logs in slash areas can be based on the consistent measurements only. In a prolonged hot, dry period, typical samples read 6 percent at 1/8-inch, 8 percent at 1/4-inch, and 10 percent at 1/2-inch depths.

Angle of exposure of the log surface to the sun greatly affected wood temperature. Even at the 1/2-inch depth, wood reached 110° F. when nearly perpendicular to the sun's rays in an air temperature of only 88° F. On the shaded side, wood temperature differed little from air.

Plans for 1963

We plan to complete analysis of records on the paired slash burning plots, continue tests of measures of slash moisture content, and gather more records of slash-fire and wildfire behavior as related to pertinent factors.

FIRE WEATHER

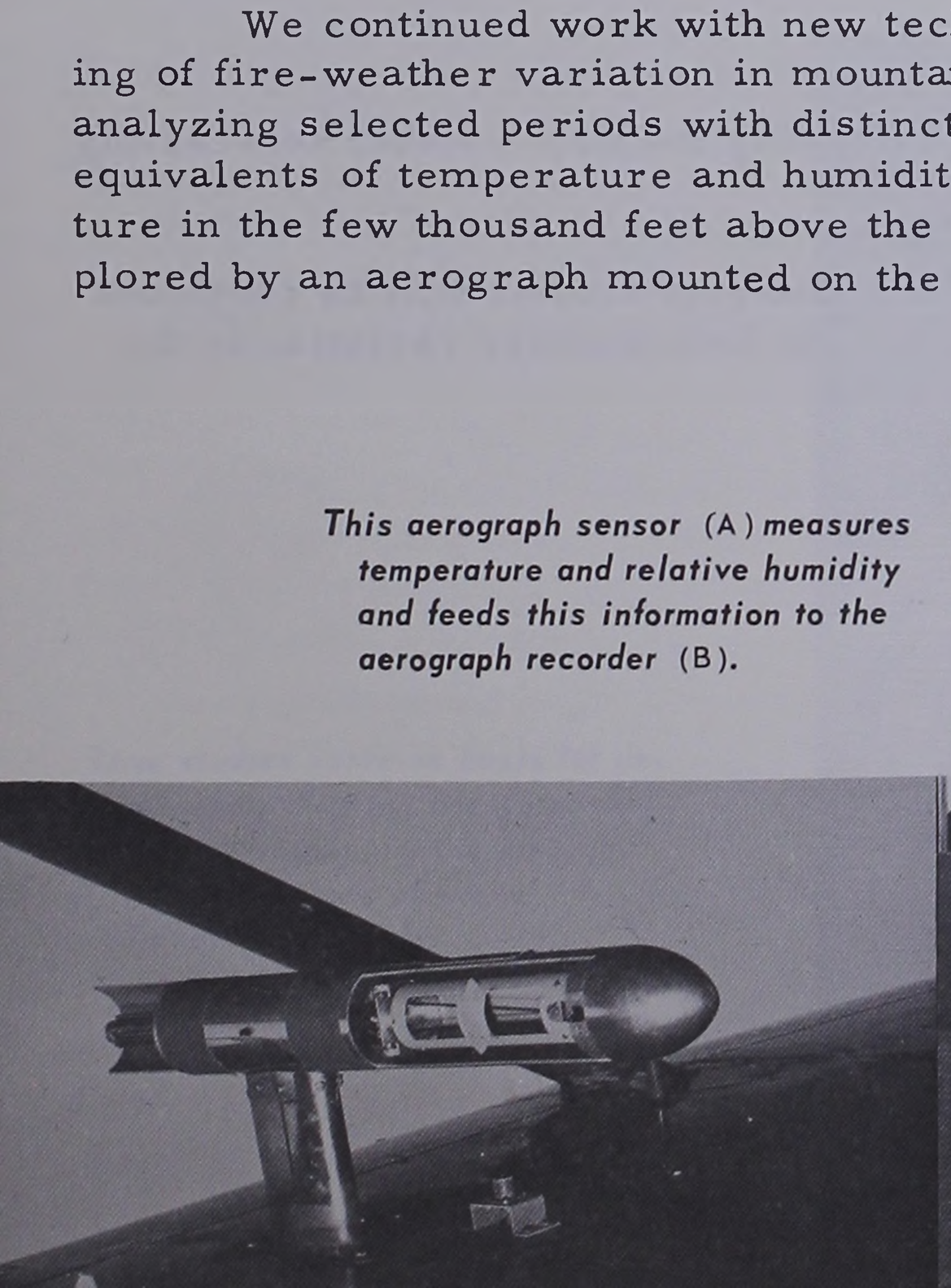
Owen P. Cramer, project leader, Robert E. Lynott

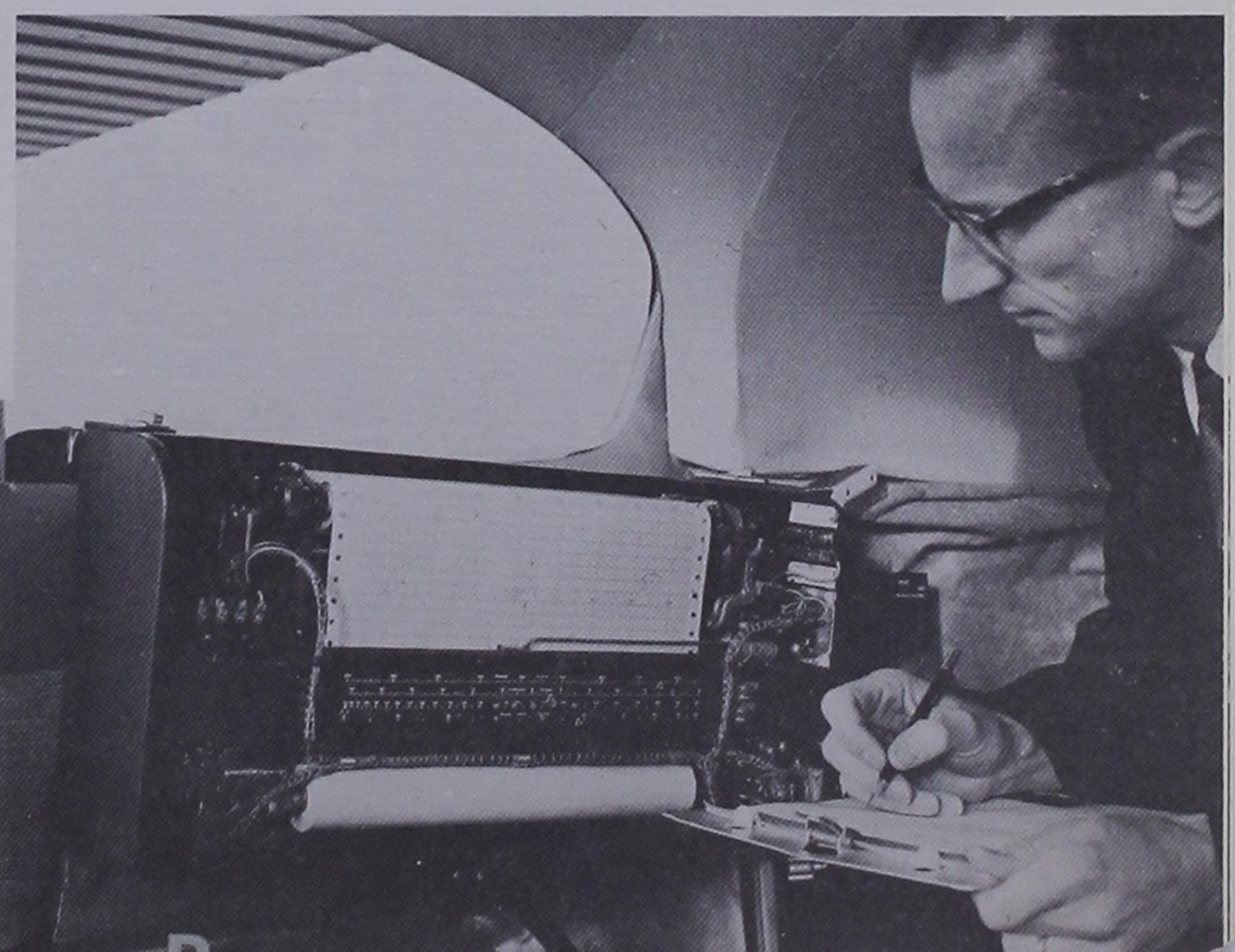
Fire-weather research efforts were divided among studies of fire-weather forecasting services, mountain-weather variation, fire-danger rating systems, and fire-season severity rating.

To provide guidelines for further intensification of fire-weather forecasting services in the Pacific Northwest, Owen Cramer and Howard Graham, Regional Office meteorologist, completed a statement of "Detailed Needs for Fire-Weather Services in Oregon and Washington as Specified by Fire Control Agencies." State, Federal, and private forestry agencies of the two States assisted in preparing this statement and have endorsed and forwarded it to the Forest Service, Chief of Fire Control, in Washington, D. C., for discussion with the Weather Bureau. Some of the proposed features underwent a limited trial on the Deschutes and Willamette National Forests the latter part of the summer.

We continued work with new techniques that may give better understanding of fire-weather variation in mountain areas. Robert Lynott is intensively analyzing selected periods with distinct weather patterns in terms of sea-level equivalents of temperature and humidity. Variations of humidity and temperature in the few thousand feet above the surface of the Cascades were briefly explored by an aerograph mounted on the Station's Cessna 180. Further tests will

This aerograph sensor (A) measures temperature and relative humidity and feeds this information to the aerograph recorder (B).





be made to develop procedures for making upper-air measurements over remote mountainous terrain. The development of both observation and analysis procedures is preliminary to planning an intensive study of fire-weather variation in the Cascades.

Several currently used fire-danger rating systems are being compared with the proposed National Fire Danger Rating System to determine their effectiveness for rating the severity of fire weather during the fire seasons of 1947-61. The comparison is being made for several portions of the Region and is based on correlations between the season average fire-danger indexes and certain fire-occurrence statistics.

A routine analysis was made of the severity of the 1962 fire season in the Pacific Northwest. Details are in "The 1962 Fire Season in the Pacific Northwest" by Owen Cramer. Severity was slightly below normal in Washington and northeast Oregon and normal in western and south-central Oregon. Lightning storms were comparatively few in most areas and started notably few fires. Outstanding fire-season weather characteristics were the record-setting low temperature and rains of May and the wetting rains of early August and early October. Fire occurrence on west-side forest areas was similar in most respects to the occurrence pattern that would have been expected under similar weather conditions in the 1944-56 base period. The outstanding exception was the continuing upward trend in number of man-caused fires on west-side National Forests. On most west-side forest areas, more fires were held to a quarter acre than would have been expected in the base period, and fewer reached 10- and 100-acre sizes. Most spectacular weather event of the fire season was the Columbus Day blowdown that greatly increased the fire-hazard rating on much west-side forest land.

Plans for 1963

Further trials of proposals for intensifying the fire-weather forecasting service are planned.

Preliminary observation and weather analysis studies will be continued as groundwork for the planned intensive study of fire-weather variation in the Cascades.

Forest Economics Research

CARL A. NEWPORT, Division Chief

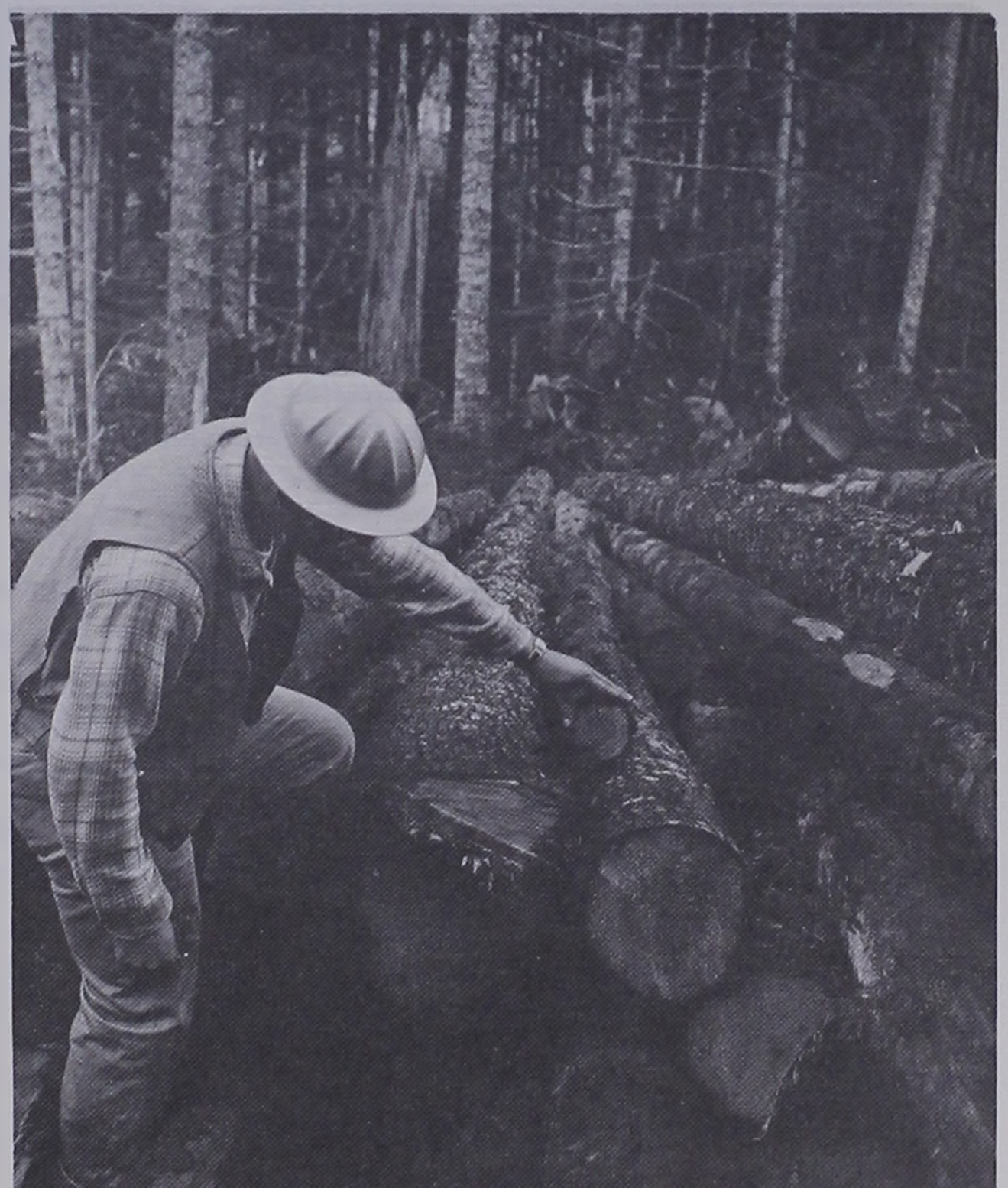
FOREST PRODUCTS MARKETING

Thomas C. Adams, acting project leader,
Virgil W. Binkley, and Walter H. Mead

Each step in the conversion of timber to useful products has its own problems related to marketing. These problems arise, in part, from the wide range of sizes, species, form, and quality of individual trees and logs and from differences in location, ownership, and accessibility. Marketing research aims to improve the overall marketing system and to develop markets for little-used raw materials.

Analysis of Thinning Costs and Values

A large share of our marketing research effort is currently directed toward analysis of time and production rates in thinning Douglas-fir. An economic study is underway in which information is being developed on logging costs and conversion values as related to size and type of material, average volume per acre, distance from roads, and other factors.



Time studies serve as basis for determining thinning costs and conversion values, by log size. (Photo courtesy of Crown Zellerbach Corp.)

Potential cost savings in subsequent thinnings are being explored, as compared to logging costs of initial thinning operations.

Costs of Skyline Logging Methods

Studies of the economic and engineering aspects of skyline logging methods are in progress. At Cascade Head Experimental Forest, time, production, and cost data for logging with the Skagit radio-controlled Sky Car is being collected. This method uses a skyline, one-half mile or more in length, and yards laterally up to 300 feet each side of the skyline. The lateral yarding line is powered by a self-contained engine in the Sky Car.

Skagit radio-controlled Sky Car in operation at Cascade Head Experimental Forest.

A second study, at H. J. Andrews Experimental Forest, is making a similar analysis of the 10-ton Wyssen skyline system. This method uses a single operating line and an automatic carriage which hooks on and releases from a movable stopping device mounted on the skyline.

Both methods are designed to make logging possible on steep slopes previously considered inoperable due to inaccessibility and unstable soil

conditions. Successful development of these methods will permit marketing of additional raw material and aid soil management on such areas. They also may have a potential for lower cost logging of less critical areas, due chiefly to potential savings on truck-road development and transportation costs.

Log Exports

Periodic reports have been continued during 1962 on the extent and impact of log and lumber exports from the Pacific Northwest to Japan.

Log exports from Oregon and Washington reached a peak in late 1961 and have declined sharply since that time.

	M Board Feet Scribner Log Scale		
	Oregon	Washington	Total
Period:			
1960:			
1st quarter	5,456	2,312	7,768
2nd quarter	5,205	3,297	8,502
3rd quarter	5,422	2,311	7,733
4th quarter	11,961	4,987	16,948
1961:			
1st quarter	14,153	9,534	23,687
2nd quarter	27,488	26,107	53,595
3rd quarter	53,207	44,620	97,827
4th quarter	41,942	60,930	102,872 (Peak)
1962:			
1st quarter	33,081	38,511	71,592
2nd quarter	25,892	36,492	62,384
3rd quarter	14,937	19,420	34,357

Chief species of log export are Port-Orford-cedar, western hemlock, and the true firs. Douglas-fir logs have steadily decreased in relative importance, except for thinnings which come largely from industrial tree farms under professional forest management.

The overall impact of log exports on the Pacific Northwest lumber industry has moderated since 1961, and some of the larger industrial tree farm managers are endeavoring to work log exports into their regular program of operations where this outlet may be complementary to their regular domestic markets.

Public Timber Sales

An analysis of public timber sales for the past 10 years is underway. Multiple correlation techniques are being used to isolate the principal factors which influence the price bid for Forest Service and Bureau of Land Management timber sale offerings. Among the factors being tested are number of bidders, road cost, size of sale, distance to market, and various leading economic indicators. It has taken a great deal of time and effort to organize the data into a standard format for analysis.

Plans for 1963

On completion of present studies, additional studies will be undertaken to improve efficiency of marketing forest raw materials, and to develop new markets for such material. Such studies are expected to deal with marketing arrangements and cost factors associated with alternative thinning methods and other intermediate and salvage cuts, in both young-growth and old-growth forests. Further applications of skyline logging methods are also contemplated.

MULTIPLE-USE ECONOMICS

Carl A. Newport, acting project leader, Jay M. Hughes

This project is to evaluate alternative forest land uses and to develop and recommend guidelines for selecting the optimum combinations of resource use. The first study, when completed, will be a series of photographs of roadside areas whose forest cover types vary by age and volume per acre. Pictures of each type before and after various silvicultural treatments will present the landscape effects as seen by the forest traveler. Matching economic appraisals of the resulting timber production will be presented for each type and treatment.

Plans for 1963

New studies are being planned to work on pressing multiple-use problems. Most of these problems are connected with the heavy and increasing demands on the forest, followed by intensification of management, which, in turn, results in real and/or apparent conflicts of uses.

PRODUCTION ECONOMICS

Carl A. Newport, acting project leader, Donald F. Flora,
Robert O. McMahon

In cooperation with the Umpqua National Forest and the Region 6 Division of Timber Management, a study is underway to investigate the benefits realizable through a more rapid and flexible road development program on National Forests than is now permitted under present road financing practice. A comprehensive study plan has been completed and data collection has begun and will be continued in 1963.

A cooperative agreement has been signed with the Bureau of Land Management to provide them with economic advice relative to intensive management of young growth on a 55,000-acre study area in Tillamook County. Our first efforts are being directed toward an analysis of existing and potential markets for products of young-growth management.

Weyerhaeuser Co. and the University of Washington are cooperating with us on a study of the financial aspects of advance roading to permit thinning otherwise inaccessible stands. Alternatives being examined on a 3,600-acre portion of the Clemons Tree Farm are: (1) complete roading within 10 years, (2) roading within 20 years, and (3) delaying roadbuilding until time of harvest. This study will continue into 1963.

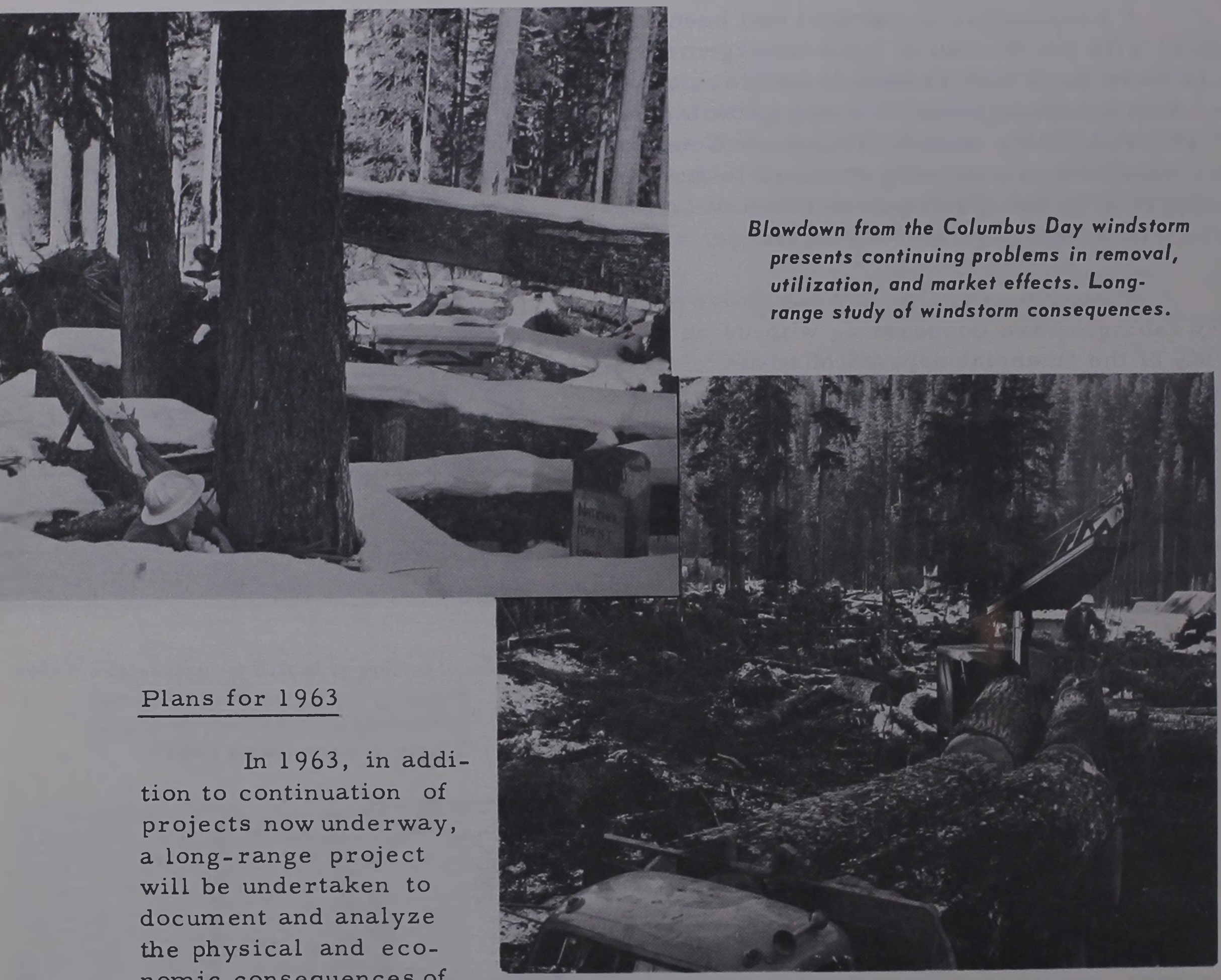
Many of our studies in forest production economics require the expression of growth and yield data in terms that lend themselves to economic analysis. To fill one such need, tables of growth percents for individual Douglas-fir trees were prepared for over 5,000 combinations of site, age, diameter, and growth rate in rings per inch. Publication is scheduled for 1963.

Our studies of the economics of dwarfmistletoe control in ponderosa pine stands continue. Costs of eradication by thinning and pruning under various conditions can now be predicted for almost any pine stand. Evaluation of return from dwarfmistletoe control awaits completion of impact and intensification

Small patches of bugkill in merchantable timber frequently are lost to decay when road systems are not completely developed. Umpqua advance roading study.

studies of the Division of Forest Disease Research. Conclusions are expected to have application throughout the range of ponderosa pine.

An appraisal of the trend and current status of reforestation in the Pacific Northwest has also been completed. The accumulated data on the annual amount of reforestation and its cost, the backlog of nonstocked areas, and trends in planting and seeding will provide a basis for planning further studies of the economics of reforestation.



Blowdown from the Columbus Day windstorm presents continuing problems in removal, utilization, and market effects. Long-range study of windstorm consequences.

Plans for 1963

In 1963, in addition to continuation of projects now underway, a long-range project will be undertaken to document and analyze the physical and economic consequences of the Columbus Day windstorm. Also, attention will be given to application of research techniques to thinning and pruning schedules, growing stock levels, and rotation ages for individual management units of large Douglas-fir timberland holdings.

FOREST SURVEY

Melvin E. Metcalf, project leader, John M. Berger, John H. Beuter,
Charles L. Bolsinger, Donald R. Gedney, Charles C. Hawks,
John W. Hazard, Richard L. Nielsen, Richard C. Smith

In 1962 Forest Survey crews completed the field work for the reinventory of 5.8 million acres of commercial forest land in the Oregon counties of Coos, Curry, Douglas, Jackson, Josephine, Lane, and Lincoln. Previous inventories for these counties ranged in date from 1948 to 1956. During this same period, an additional 2.3 million acres in four National Forest working circles were reinventoried by National Forest inventory crews on the Willamette, Fremont, Winema, and Ochoco National Forests of Oregon.

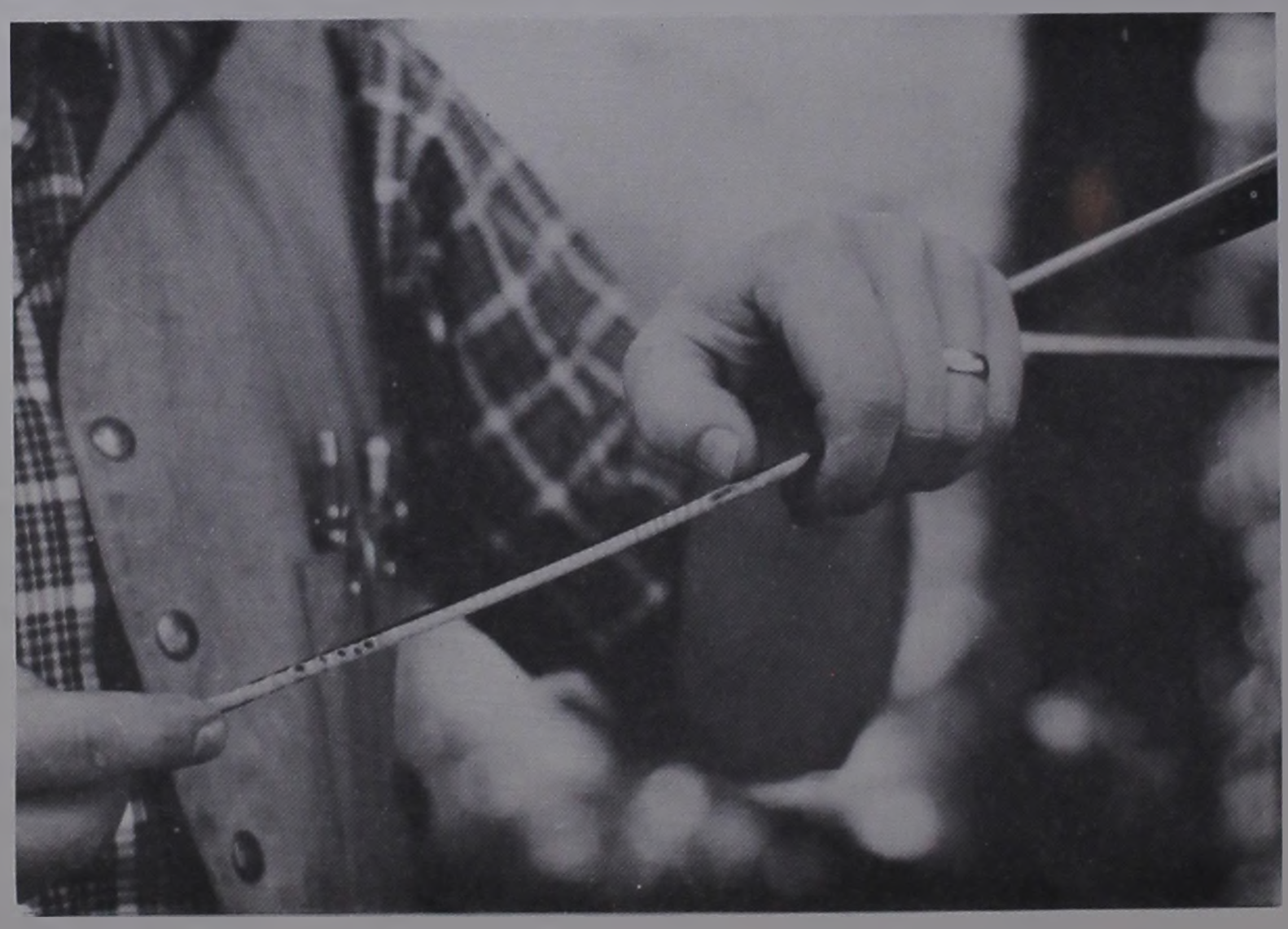
Forest Survey inventory plots are marked so that they can be relocated and remeasured.

Compilation of data for 12 western Oregon counties inventoried in 1961 was practically completed and results will be issued in 1963. The counties are Benton, Clackamas, Clatsop, Columbia, Hood River, Linn, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill.

Forest resource reports were published for Okanogan, Clallam, Jefferson, King, Pierce, and Kitsap, Island, and San Juan Counties, Washington. Reports have also been completed and prepared for publication for northeastern Washington (Ferry, Lincoln, Pend Oreille, Spokane, Stevens, and Whitman Counties) and Chelan and Douglas Counties. These reports will be issued early in 1963.

Procedures were developed and work has been carried on to revise and update forest resource data for the 1962 recompilation of Forest Survey statistics. These statistics will also provide the base for evaluating the future role of the forest industry in the Columbia Basin, a task we are carrying out in cooperation with the Bonneville Power Administration. The results of this evaluation will be used to estimate future electrical power requirements of the forest industry in Oregon, Washington, Idaho, and western Montana.

In cooperation with forest industry and National Forest Administration, phase I of the Western Wood Density Survey, the collection of increment cores, was completed in the States of Oregon and Washington. A total of 1,878 wood density plots have now been examined, yielding approximately 10,000 cores for analysis by the Forest Products Laboratory.



Increment cores from Wood Density Survey plots provide estimates of tree specific gravity.

Plans for 1963

Plans are to complete analyses and reports now underway, to complete field work for the reinventory of six counties in southwestern Washington, and to publish new inventory statistics for northwest and southwest Oregon.

SURVEY TECHNIQUES

Robert B. Pope, project leader, David A. Bernstein,
Colin D. MacLean, and John D. Wear

Survey techniques studies are conducted to develop improved methods of making the nationwide Forest Survey, timber management plan surveys, and forest insect surveys. Region 6, U.S. Forest Service, cooperates in this program by conducting administrative studies directed toward problems of application. Although aerial methods are still prominent in this program, we are attempting to increase our efforts in other aspects of inventory and mensuration.

Forest Survey Procedures

Although the basic field and office procedures for the current Forest Survey design have been in effect for several years, we are still striving to refine our methods to the point of maximum efficiency.

We are continuing to work out better methods of using aerial photo plots to improve our estimates of commercial forest area and total volume. We are also analyzing data from remeasured plots to learn what problems arise and what can be done about them. This should help us to get better information from old permanent plots and do a better job of establishing new ones. In addition, we subjected our definitions and procedures for area-condition classification to a critical examination in the field. This has resulted in some changes in the definitions of desirable and acceptable trees, and has provided a basis for developing an improved method for collecting area-condition-class information.

Timber Management Plan Surveys

This year we conducted two studies aimed at getting more management information from aerial photos. One was a test of stand age estimation from aerial photos; the other was to determine how accurately the volumes of small areas could be obtained by direct photo estimation.

We also prepared several guides to help field personnel in the evaluation of brushfields in southwestern Oregon, timber type mapping in the Pacific Northwest, and planning thinning operations in young-growth Douglas-fir.

Forest Insect Surveys

This year we conducted an operational test of previously developed methods for using aerial photos to assess the mortality caused by bark beetle epidemics. Mortality estimates were made on five problem areas of the Fremont National Forest to see if this technique would be cheaper than a straight field survey of comparable accuracy.

We are also making a test to see if the basic aerial-photo methods developed for epidemic conditions can be modified for use in keeping track of the normal annual mortality that occurs when beetle populations are endemic.

Dissemination of Information

Each year we assist in several photo-interpretation training programs and consult with others on various survey problems. The training includes both regular programs for Forest Service personnel and short courses at universities. This year we joined with the Station's Statistical Service and the Division of Forest Management Research in designing an inventory of animal damage on forest plantations. We also accepted the responsibility for designing an inventory of blowdown caused by the high winds of October 12, 1962.

Plans for 1963

Emphasis in 1963 will be placed on determining the most efficient use of photo plots for volume stratification, working out improvements in permanent plot procedure and data analysis, improving the collection and interpretation of area-condition-class information, and further refinement of the use of aerial photos to assess the mortality caused by endemic beetle populations.

Forest Management Research

GEORGE S. MEAGHER, Division Chief

SEEDING, PLANTING, AND NURSERY PRACTICE

William I. Stein, project leader,
James M. Trappe, Kenneth W. Krueger

The seeding, planting, and nursery practice project expanded in 1962 from two to three scientists. This project is headquartered at Portland with Dr. Krueger stationed at the new Forestry Sciences Laboratory at Corvallis, Oreg. Excellent opportunities now exist for teamwork on solving regeneration problems since staff specialties include physiology, mycology, and ecology.

Seedling physiology studies are conducted by Dr. Krueger in the Forestry Sciences Laboratory, Corvallis, Oreg.

Research objectives for the project were redefined in 1962. Future research will aim toward these long-term goals:

1. Evaluate the biological consequences and differences, if any, of establishing plantations from seed or from planted trees.

2. Determine seedling silvical characteristics of Northwest tree species to provide basic information on their environmental needs.

3. Improve methods of seed collection, handling, storage, and germination.

4. Investigate production of nursery stock to improve seedling capacity for survival and rapid growth when outplanted.

Certain parts of these goals overlap, so that individual studies may contribute information toward more than one goal.

Five new studies were planned and started during the year:

1. Seasonal trends of food reserves and growth of Douglas-fir seedlings.

2. A critical look at shingle tow as a packing medium for forest seedlings.

3. Stimulating seed germination of Douglas-fir and noble fir with hydrogen peroxide: effect of solution strength and soaking duration.

4. Time of lifting of year-old Douglas-fir as it affects field survival.

5. Anatomy of root initiation and development in Douglas-fir seedlings of different ages.

The latter two studies are being carried out under cooperative agreements with the University of Washington and Oregon State University, respectively.

A major literature review on the fungus associates of ectotrophic mycorrhizae was completed and published this year. It provides an early step in determining which fungi offer greatest promise for aiding seedling survival of Northwest species. The review, covering worldwide literature, lists the species of fungi reported to form mycorrhizae on specific tree genera and species. The limited literature on the comparative effects of two or more fungi on a given host species is also covered.

Plans for 1963

Current studies will continue through 1963. Hence, little new work will be undertaken. Completion of several major manuscripts will be emphasized.

TREE-SOIL RELATIONS

Robert F. Tarrant, project leader

Work in 1962 was directed toward completing field phases of several studies, analyzing data, and preparing manuscripts reporting results. One of these studies, that of comparing nitrogen and organic matter in soils beneath a mixed plantation of Douglas-fir and red alder and those beneath a pure Douglas-fir plantation, has been completed and the report accepted for publication in 1963.

Also completed this year was a study of young ponderosa pine after soil fertilization and intermittent irrigation. Data includes height and diameter growth, nutrient uptake, alterations in foliage nutrient content, and nitrogen-phosphorus ratio. This study represents a 6-year cooperative effort with the forest genetics project and will shed further light on the manner in which ponderosa pine responds to fertilizer.

Our participation continued as coinvestigator in National Science Foundation Grant G-21015 with Oregon State University. This project, titled "Influence of Alnus rubra on microbial activity and nitrogen transformation in soils," is directed toward determining the fertility factors contributed by red alder to the benefit of interplanted Douglas-fir and the influence of nitrogen transformation, organic matter changes, and soil physical properties.

Measurements have been completed and data analysis begun on a study of Douglas-fir seedling moisture content. This is an outgrowth of work aimed at determining relations between seedling moisture content and soil factors, and appears to offer some interesting leads for further investigation.

Plans for 1963

Two studies are planned for initiation next year. The volume and nutrient content of litter from pure alder, pure conifer, and from mixed alder-conifer stands will be determined in a study to be installed soon. In another study planned for a 1963 start, the influence of stand density in a Douglas-fir plantation on chemical and physical soil properties and on the soil moisture regime will be determined for successive years. In addition to these two studies, exploratory work will be done on nutrient cycling of Douglas-fir litter in stands thinned to various densities.

BRUSHFIELD RECLAMATION

Henry J. Gratkowski, project leader

Ecological studies of varnishleaf ceanothus were pursued during 1962 in an effort to develop silvicultural methods that will control encroachment of ceanothus after logging. Studies were made of seed anatomy and structural characteristics of the impermeable seedcoats of varnishleaf ceanothus seeds. Experiments were also carried out to determine stratification requirements of the seeds, to learn the effect of hot water treatments on germination, and to study germination of seeds after exposure to temperatures up to 120° C. in dry soil for periods up to 40 minutes. In addition, dead and dying ceanothus was sampled under pole-sized Douglas-fir in an effort to determine the age at which varnishleaf ceanothus is killed by shading in western Oregon. All data has been analyzed and an article covering these and earlier phases of the work is being prepared for publication.

An earlier study (Research Paper 42) revealed that low-volatile esters of 2, 4-D and 2, 4, 5-T inhibited height growth of Douglas-fir. Annual height growth of these trees during the period 1959-62 has been measured in an effort to learn how long inhibition persists after spraying.

Field work has been completed for a study of seasonal variation in toxicity of herbicides to Douglas-fir and ponderosa pine saplings and to associated brush species. Results may show successful methods for releasing pine regeneration from brush competition. Specially formulated herbicides for this study were provided by Amchem Products, Inc. Field work has also been completed on: (1) a study of height growth of Douglas-fir after release from varnishleaf ceanothus and (2) a study of the effect of repeated applications of herbicides on brush species in southwestern Oregon.

In addition, personnel cooperated with the Bureau of Land Management, several National Forests, and one private company in project-size trials of aerial application of herbicides.

Plans for 1963

Completed studies will be prepared as manuscripts, and the brush control and brushfield reclamation program will be reevaluated to determine the course of future research.

ANIMAL DAMAGE CONTROL

Norman P. Worthington, acting project leader,
M. A. Radwan, Francis R. Herman

This is a program to appraise the nature and extent of animal damage to seed and trees in the Pacific Northwest and to develop safe, effective, and practical protection methods.

An analysis of the problem and suggestions for a short-term laboratory program were prepared. Plans for the next 5 years include investigation of the properties and effectiveness of chemicals used for seed and seedling treatment and study of factors affecting wild mammal preferences for tree and browse species. These studies will complement investigation by the Olympia Station, U.S. Bureau of Sport Fisheries and Wildlife.

An extensive review has been prepared covering the problem of wild mammals. Their injurious activities, resultant damage, and known and suggested means of damage control are classified, and accomplishments as well as existing problems are discussed with emphasis on chemical and physiological research.

A study of the effect and persistence of the fungicide and bacteriostat TMTD on soil microorganisms in nursery soil has been initiated. This chemical is used extensively as a protective treatment of planting stock prior to lifting from nursery beds to repel hares or rabbits.

A plan for assessing mammal-caused damage to new plantations furnishes a pattern for more extensive cooperative inventories of animal damage. The information secured can also be used as a springboard for field studies into direct and indirect methods of animal control.

Plant physiology phases of animal damage control are studied in a well-equipped laboratory.

Plans for 1963

Research effort in 1963 will be directed toward studies with radioactive tetramine to determine its stability and leachability in soil and absorption, translocation, and metabolism by different plant species.

FOREST GENETICS

Roy R. Silen, project leader, Frank C. Sorensen

This project covers a variety of studies and cooperative endeavors aimed to develop genetically improved forest trees in the Northwest. Most activity centers at the Forestry Sciences Laboratory, Corvallis, Oreg., but field studies are located from southern Oregon to northern Washington.

Primary emphasis of 1962 publications has been provenance studies, seed orchard technology, species introduction, and genetics of individual traits.

Investigations are continuing in these fields. For example, the preparation of a major publication on racial variation in ponderosa pine has suggested many new lines of inquiry into the Station's 50-year-old provenance studies in Douglas-fir. The continuing investigations are giving better insight toward nursery culling practices, movement of planting stock, progeny testing techniques, and parental influences on such traits as wood quality, form, and resistances to various pests.

In seed orchard technology, present work is aimed to overcome the problems of pollen contamination by using fertilizer and chemical control measures to influence the size and periodicity of the seed crop. Other studies are aimed to overcome the past low success in field grafting of white pine.

In the area of genetics of individual traits, heritability estimates are being made as appropriate data accumulates in our provenance and clonal studies. In addition, a number of crosses were made this year between those clones in the Dennie Ahl Seed Orchard that strongly displayed some particular trait such as growth, heavy cone production, maleness, earliness, grafting compatibility, and limbiness. The aim here is to set up the basic crosses for selection and recombination over several generations.

Plans for 1963

As in past years, will continue to assist scientists at Oregon State University on joint studies, and assist Region 6 with their seed orchard problems. Will remeasure and maintain provenance studies and prepare a manuscript on results from our 50-year-old Douglas-fir heredity study. Plan to complete a manuscript on pollen contamination studies and continue investigations into individual traits of Douglas-fir and better seed set in seed orchards.

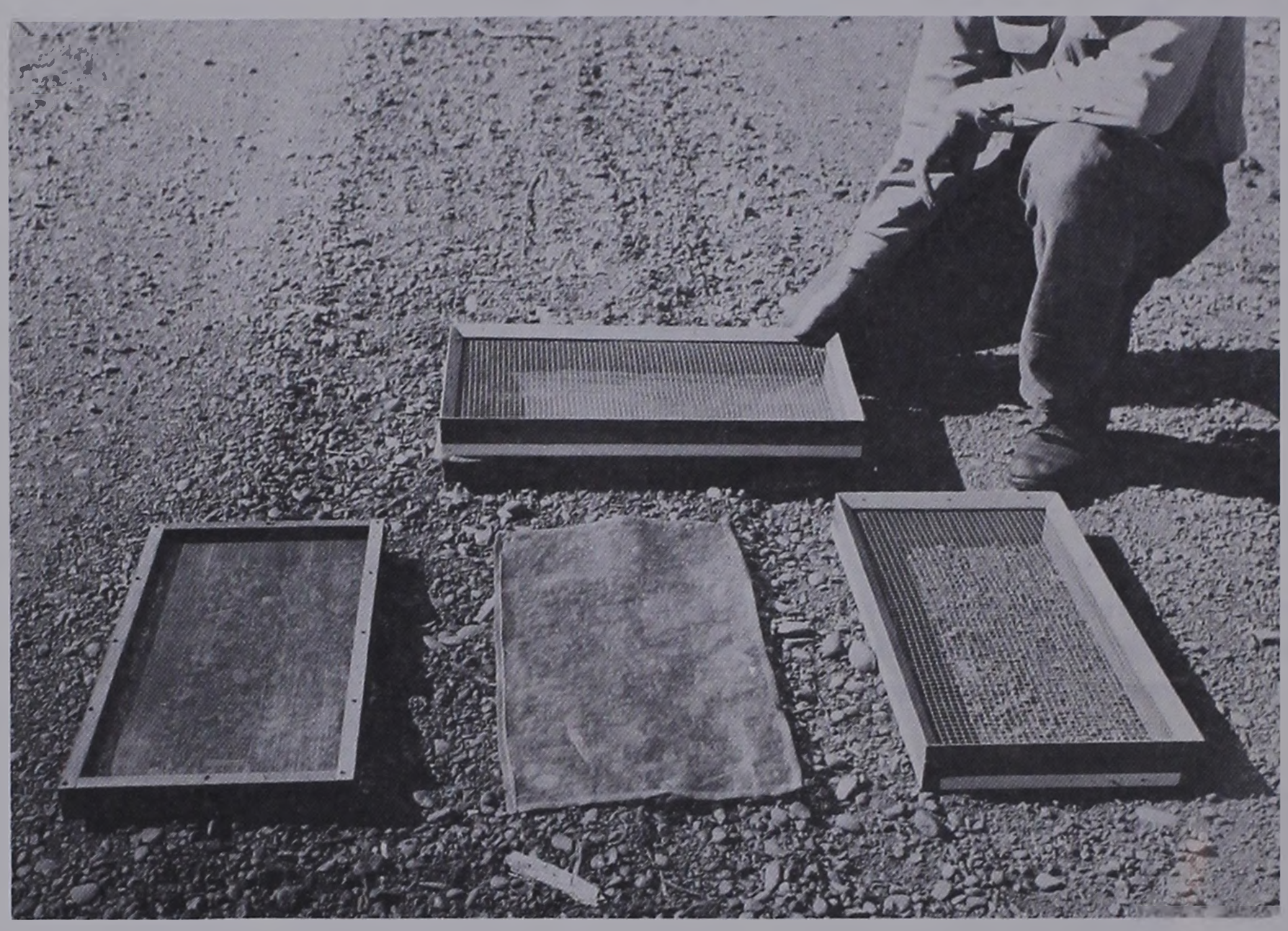
SILVICULTURE OF DOUGLAS-FIR

Norman P. Worthington, project leader,
Edward J. Dimock II, Donald L. Reukema, Richard L. Williamson

In an endeavor to point the way to intensive forest management for more and better products on less land, research emphasis has centered on studies in silvics, regeneration, stand improvement, thinning, growth and yield, and harvest cutting. Work ranging from collection of field data to preparation of manuscripts was carried out on 22 studies in these fields during 1962. Of these, eight are being terminated as each study's objective is completed.

Seasonal progress of height and diameter growth for young Douglas-fir was determined by careful weekly measurements.

Field data were collected and analyzed for continuing studies involving seed and litter fall as influenced by thinning, effect of release on diameter and height growth, photosynthetic efficiency of tree crowns, long-term effects of early precommercial thinning, planting methods in bracken types, and growth of young hemlock-spruce stands. Commercial thinning studies also were continued in 30- to 65-year-old Douglas-fir and hemlock stands. Manuscripts reporting results for eight studies were completed.



A seed-trap liner of nylon tent screening facilitates collection of tree seed.

A new problem analysis was prepared to guide the research program over the next 5 to 10 years. Greater emphasis will be placed on silvics, intensive management in very young stands, and harvest-cutting and rotation-age determination. Formal studies of growth and yield in unmanaged stands have been turned over to cooperating agencies, who will continue them. Cooperative studies to determine guidelines for controlling levels of growing stock in young stands have been undertaken. A new study in cooperation with the University of Washington will appraise relative tolerance of several native conifers. An analysis is in progress to determine what constitutes the most efficient growing stock and what considerations affect rotation length in older stands that have been under commercial thinning management.

Five publications were issued, reporting on (1) first 6-year results of commercial thinnings in a 40-year-old Douglas-fir stand; (2) frequency of logging wounds and severity of decay associated with thinning young Douglas-fir and hemlock stands; (3) potential veneer grades from pruned Douglas-fir; (4) establishment of shelterwood cutting study in 60-year-old western hemlock, and (5) management and utilization of red alder.

Plans for 1963

In 1963, research will emphasize more work on the influence of competition and release on individual trees, effect of initial spacing on growth and yield, and additional field installations for the cooperative levels-of-growing-stock studies.

SILVICULTURE OF TRUE FIR-MOUNTAIN HEMLOCK AND SITKA SPRUCE-WESTERN HEMLOCK TYPES

Robert H. Ruth, project leader, Vern P. Yerkes,
Jerry F. Franklin, Carroll B. Williams, Jr.

The objective of this true fir-mountain hemlock and Sitka spruce-western hemlock project is to learn basic principles and recommend detailed practices for the harvest, regeneration, and culture of these forest types and for the coordination of timber production with other land uses. Over 5 million acres of commercial forest land are involved. Part of this land is in the coastal "fog belt" where Sitka spruce and western hemlock grow in an area of equable temperatures, frequent rainfall, and summer fog to form forests that are among the most productive in the Nation. The other part is at higher elevations in the Cascade Range and Olympic Mountains where the true fir-mountain hemlock forests grow in an area of greater temperature extremes, heavy snowfall, and high watershed values. Because of the mixture of species in these forests and their occurrence over a wide variety of soil, topographic, and climatic conditions, silvicultural problems are complex and challenging.

Current research in the coastal forests includes a comparison of the silvicultural effects of skyline-crane yarding and high-lead yarding on steep slopes. The skyline-crane system may cause less soil disturbance and damage to advanced regeneration and be advantageous in areas of erodible soil and high watershed value. In another area the shelterwood system of harvest cutting is under test to determine its adaptability to coastal forests.

Research in high-elevation forests started in 1960 with emphasis on literature review and program planning. Current research includes a study of cone production by noble and Pacific silver fir, mountain hemlock, and western

white pine. Plots have been established throughout the region, and annual examinations of cone crops will be made on permanently tagged trees. Other studies concern cone development and seed maturity of noble fir and a classification of the habitat types in the high-elevation forests of the southern Washington Cascades.

Several studies in coastal forests were completed during the year and results published. A 20-year growth record on red alder plots indicated that precommercial thinning did not stimulate growth of residual trees. March and April basal applications of phenoxy herbicides on salmonberry plants produced 100-percent defoliation and kill. Red alder was found to be readily killed by herbicides with growing-season basal treatments but was resistant to dormant-season treatments. Bibliographies with abstracts were published as guides to available literature on noble fir and mountain hemlock.

Plans for 1963

A bibliography on Pacific silver fir will be released soon, completing the literature review on a third important high-elevation species. The noble fir seed maturity study will be completed and work will continue on cone production and habitat type classification. In coastal forests increased emphasis will be given to studies of the shelterwood system of harvest cutting and to analysis and reporting of current studies.

SILVICULTURE OF MIXED PINE-FIR FORESTS

William E. Hallin, project leader, Richard P. Pharis

A program of research on physiology of major conifer species was initiated with emphasis being placed on plant-water relations since soil moisture is an important factor in successful regeneration.

All data has been collected, and results are currently being analyzed from drought studies which compared the relative drought resistance of Douglas-fir, grand fir, ponderosa pine, sugar pine, and incense-cedar and established lethal foliage moisture contents for predicting the whole plant death.

Examination of conifer seedlings during drought experiment designed to obtain foliage moisture content lethal points.

A study measuring the diurnal and seasonal variation in needle moisture content for well-watered seedlings of five conifer species has been in progress since April and will extend through June of 1963. Results will provide information on (1) water relations and (2) growth and development.

The effect of screening and mixing soil on growth of plants has often led to questioning the results of pot experiments in relation to growth under natural soil conditions. A recently completed study involving early growth of Douglas-fir and ponderosa pine from seed in pots of disturbed and undisturbed basalt clay soil should provide some useful answers.

The study comparing early growth of sugar pine, ponderosa pine, Douglas-fir, grand fir, and incense-cedar on three soil types has been extended in part to two additional soils. Lifting and measuring of seedlings has been completed.

The first 5-year height measurement has been completed for the sugar pine plantation spacing study.

A 3-year record of soil moisture for an old-growth area and an adjoining cutover area were completed on the South Umpqua Experimental Forest. Seasonal changes in soil moisture at 6-, 18-, and 36-inch depths were compared.

The field work for an exploratory study of soil moisture and surface soil temperature was completed on a steep southwest slope of a clear-cut unit. Under a variety of shade and vegetation conditions, soil moisture was measured at 6- and 12-inch depths in June and August, and maximum surface soil temperatures were measured for June, July, and August.

Plans for 1963

Analysis of data for physiology studies now in progress will be completed and the manuscripts prepared. After analysis of current study results, additional physiology studies in water relations will be started.

A new study of soil moisture on recent clearcuts will be started, and manuscripts will be prepared for the study comparing soil moisture for an uncut stand with that for an adjoining clearcut for the exploratory study of soil moisture and maximum surface temperatures.

A study of Douglas-fir diameter-growth patterns in relation to soil type and other factors will be started.

SILVICULTURE OF INTERIOR CONIFER TYPES

Carl M. Berntsen, project leader, Edwin L. Mowat,
Walter G. Dahms, James W. Barrett

Accomplishments during 1962 consisted primarily of completion of some studies of long standing in mature stands and the continuation of newer studies in immature stands.

An "initial spacing" study in ponderosa pine saplings, established in 1958, was measured for soil-moisture depletion, using a neutron probe device. Moisture measurements at 3-week intervals through successive growing seasons are adding depth to the study objective to determine growth response of trees of various stand densities. Explanatory studies in soil-moisture evaporation and field capacity were initiated this year to distinguish water used by trees from losses to gravitation and evaporation.

A neutron-scattering device was used to trace the movement of introduced water through pumice soil until equilibrium on field capacity was reached.

An 8-year study of regeneration was completed in the ponderosa pine–white fir transition zone. It demonstrated that such areas can be restocked to pine after heavy partial cutting, but positive action must be taken to control rodents, to eliminate most of the advance fir reproduction, and in some places to reduce the slash and scarify the soil surface.

A study to determine optimum levels of lodgepole pine growing stock was established in a 45-year-old stand. This installation supplements a previously established study of similar design in a 27-year-old stand.

Field work was completed on our phase of an interregional set of site index curves for lodgepole pine that included a correction for stand density.

The stem analysis phase of a gross-growth study for lodgepole pine showed that individual trees usually do not retain the same relative height in a stand throughout life. From this lead, a method was devised to determine site index of a stand at various ages that is free from error caused by changes in relative height of individual trees. This was done by relating site index to height of the tallest individual tree for past stand ages as determined by stem analysis of several currently tallest trees.

Stem analysis of tallest trees of a given stand was used to determine height of individual trees for past ages for site index purposes. Age-height relationships were determined from discs cut at ground level, at d.b.h., at 10 feet aboveground, and at 10-foot heights thereafter.

Estimates of seed production and dissemination distance were strengthened by seed collection data for the fourth consecutive year on clear-cut lodgepole tracts.

Counting lodgepole pine seeds and determining seed soundness by the cutting test. Contents of seed traps are brought into the office where the work can be done more efficiently.

A problem analysis has been completed of a new phase of the silviculture project, that of determining which species to favor on specific sites. Priority has been given to investigation of environmental factors influencing establishment and early growth of ponderosa pine and its close associate, lodgepole pine, on pumice soils of central Oregon.

Plans for 1963

Next year's plan is to carry forward ponderosa and lodgepole pine studies as listed above, with possible extension to other sites and stand ages as manpower and finances permit.

Forest Utilization Research

JOHN B. GRANTHAM, Division Chief

LOG AND TREE GRADE DEVELOPMENT

Paul Lane, project leader, John Henley, Douglas Hunt,
Eldon Estep, Marlin Plank

The increasing cost of logs and the growing importance of determining their most valuable use intensifies the need for improved timber quality standards.

During 1962, a major activity was the collecting of timber quality data for inland Douglas-fir and western larch. This information will be used to improve the precision of existing log grades, develop satisfactory tree-grading systems, and provide other basic data for evaluating standing sawtimber for these two important species.

To date, information has been obtained from about 5,000 inland Douglas-fir and 3,800 larch saw logs. These logs were from some 1,700 sample trees

Recording the physical characteristics of typical Douglas-fir saw logs in eastern Oregon prior to making a recovery study of product output and value.

Placing an identifying mark on boards from Douglas-fir logs during a recovery study at a typical sawmill in northeastern Washington.

distributed over a variety of forest types, stand conditions, sites, slopes, exposures, and elevations in Idaho, Montana, Oregon, and Washington. In addition to the information on environmental conditions, data were obtained on the physical characteristics of each log and each piece of lumber they yielded. These data are now being analyzed to develop better timber quality standards.

Marking a pile of lumber prior to kiln-drying on a Douglas-fir recovery study.

This research is a continuation of work started in 1961 and is part of nation-wide timber quality investigations by the Forest Service. Collaborating in this research are numerous sawmill operators, the Western Pine Association, other units of the Forest Service, and other public agencies.

Plans are being made to extend this research to coast-type Douglas-fir next year. In the coastal area of the Pacific Northwest, significant changes in timber utilization have taken place during the past few years. There is now, for example, considerably more overlap in the use of the same type logs for veneer and lumber. The timber industry and forest-land managers urgently need up-to-date information on product yields from logs of varying quality and different types of timber stands; more precise log grades are needed to complement advancements in wood product manufacturing.

Plans for 1963

Continue timber-quality research of the Douglas-fir Log Grade Project: lumber-yield and timber quality data, collected for inland Douglas-fir and western larch, will be analyzed to improve existing log grades for the two species; preliminary tree grades for these species will be developed for trial use; and field-work will be started on collection of timber quality data for coast-type Douglas-fir.

Taking cores from Douglas-fir sample logs to obtain data on density and growth rate.

Complete the cooperative, appraisal-base study on old-growth Douglas-fir and hemlock, now underway in western Washington; coordinate appraisal-base studies with those of the log grade project wherever possible; conduct a veneer-recovery study on a true-fir species; and continue refinement of analytical techniques designed to determine the effects of log length and defect on log value.

FOREST ENGINEERING

Hilton Lysons, project leader

A new program of forest engineering research with emphasis on timber harvesting was initiated this year. This program will permit the application of systems-engineering principles to timber harvesting. Timber production and protection as well as the harvest and transport of forest products will be considered along with related activities of multiple-use forestry that involve water, soils, and recreation.

In 1961 as a preliminary to the new program, the Station instituted exploratory studies on the application of helicopters to logging--through a cooperative agreement with Oregon State University. Under this agreement, John O'Leary, associate professor of logging engineering, has been investigating factors that would affect the feasibility of helicopter logging in the Pacific Northwest States, including Alaska.

Recently, O'Leary planned and directed for the Forest Service a 2-day test of yarding tree-length logs by helicopter. The tests demonstrated that a 4,000-pound capacity helicopter can move a log weighing 8,000 pounds when the butt end drags the ground.

This finding can be vital in determining the applicability of helicopters to logging since the several advantages of air transport are offset by high hourly machine costs. Further investigation of the possible place of air transport in harvest systems will be an important part of the new forest engineering research program.

Plans for 1963

Further develop forest engineering research in the Pacific Northwest, with initial emphasis on evaluating the place of helicopters in timber-harvesting systems.

Helicopter yarding of a 7,100-pound hemlock log during tests conducted by the Forest Service and Sikorsky Aircraft.

UTILIZATION IMPROVEMENT

Harold E. Worth, project leader

Performance of Wood in Structures

Our team effort with Region 6, to improve the design and construction of wood structures, continues to show results. The showpiece of this year's accomplishment is the new Forestry Sciences Laboratory on the Oregon State University campus. This building, besides fulfilling its primary role as a science laboratory, demonstrates how attractive, economical, and efficient a wood structure can be. Favorable reaction from the Laboratory's visitors and its excellent performance during the Columbus Day storm attest to the appeal and structural fitness of well-designed, well-constructed wood buildings.

Under construction are two other laboratories of differing wood design, one at Bend, Oreg., and the other at Wenatchee, Wash. We have hopes that these structures will lead to renewed enthusiasm for wood-constructed public buildings.

Lookouts (fire towers) are another example of a team approach to better wood construction. An advanced concept for lookout installations was developed this year under Forest Products Laboratory guidance, with the advice and assistance of Region 6 and the Experiment Station.

This timber lookout on the Siuslaw National Forest is typical of the lonely, storm-swept outposts needed for forest protection. Such installations provide excellent opportunities to test improved wood construction.

Present plans call for the new design to be used during 1963. The Region will install a prototype fire tower on the Snoqualmie National Forest and then, jointly with the Station and other forest regions, appraise its performance as the basis for a national Forest Service standard. Stressed-skin wood components are used to provide a house that is easier to transport, assemble, and maintain. Another cost-saving feature is the modular construction using simplified, interchangeable, preservative-treated timber. Performance under the severe exposure conditions of typical lookout sites will be a convincing demonstration of wood's potential in engineered structures.

The Forest Service is using more wood signs at a time when some private and public agencies are turning heavily to other materials. In an accelerated sign program, the Station and Region are collaborating with the Washington Office to engineer wood signs that minimize maintenance but retain a rustic appearance harmonious with forest settings.

The Station's wood utilization improvement project, which includes wood performance studies, is headquartered at Portland. A major goal of this project is to stimulate cooperative wood research and better utilization, both within and outside the Forest Service.

Plans for 1963

Pursue wood-utilization improvement (1) by systematically analyzing the research needs of the Northwest and vigorously supporting projects of the highest priority; (2) by actively promoting cooperative research--among public agencies, within industry, and between industry and Government; and (3) by encouraging the application of research results--working closely with industry and other research organizations and Government agencies--to achieve more and better uses of wood.

Forest Insect Research

R.L. FURNISS, Division Chief

BARK BEETLES; SUCKING, SEED, AND WOOD PRODUCTS INSECTS

K. H. Wright, project leader,
R. G. Mitchell, Charles Sartwell

Objectives of this project, headquartered in Portland, are to study the biology and ecology of the four groups of insects and to develop effective and economical means for preventing or suppressing their outbreaks by biological, silvicultural, or other means.

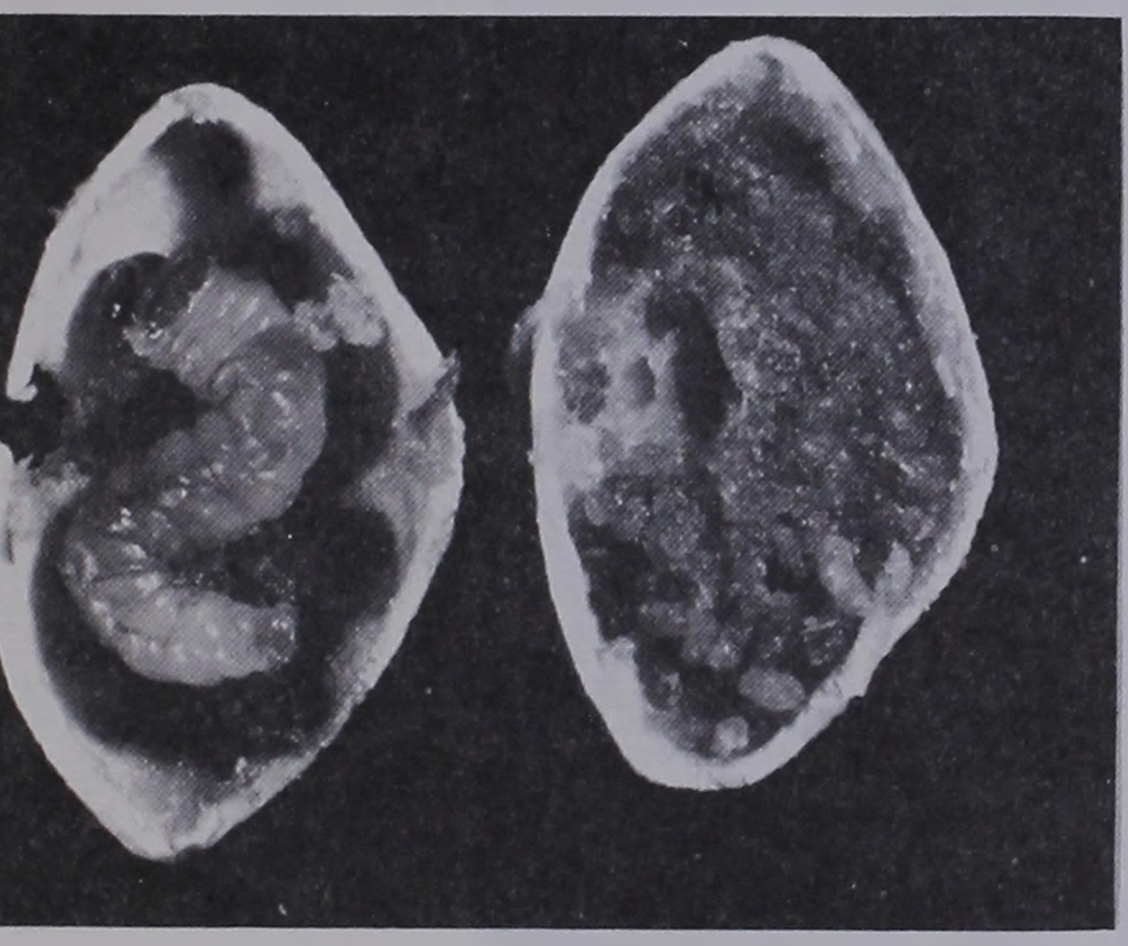
After many years, research on pine bark beetles was renewed, principally in evaluating the Oregon ips and mountain pine beetle problems in young ponderosa pine stands. Problem analyses to guide research on these two insects are being prepared.

Life history studies of mountain pine beetle in ponderosa pine are basis for developing control methods.

For several years, our research on sucking insects has been concentrated upon the balsam woolly aphid, an imported pest of true firs. Much effort has been expended in exploring the possibilities of biological control. In the last 6 years, 22 species of insect predators have been introduced into the Pacific Northwest from various parts of the world. The control value of five European species, now established on the balsam woolly aphid, is being studied.

The most intensively studied foreign predator is a small beetle, Laricobius erichsonii. Populations at five of eight liberation areas have been increasing steadily, and the predator's life cycle is well coordinated with that of its aphid host. The beetle can significantly reduce balsam woolly aphid populations; but tends to concentrate upon trees with heavy aphid populations, thus letting light infestations develop unhindered. Another characteristic of the predator has been its slow rate of spread, the maximum dispersal in the last 5 years measuring 3,500 feet from release points. To compensate for the beetle's poor rate of spread, more liberations of Laricobius are planned. Recent field tests showed that recolonization from one area to another within the region is feasible. Thus many problems of importing predators can be avoided.

Other foreign insect predators established in the Pacific Northwest for control of the balsam woolly aphid are a ladybird beetle and three species of small flies. These four species have survived 2 or more years in their new environment, and all have characteristics which could make them worthy additions to the biological control program. Several native insect predators also are attacking the aphid.



Research is in progress to control seed worms in ponderosa pine.

Investigations are being conducted, and more are planned, on relationships between the balsam woolly aphid and its several true-fir hosts. Conclusions would be premature, but there are indications that aphid infestations follow consistent patterns within and between forest stands, suggesting the possibility of reducing aphid damage by silvicultural practices.

Small-scale studies were made of insects that attack seeds and cones of Douglas-fir and ponderosa pine. On Douglas-fir, chemical-control tests were made but have not yet been analyzed. On ponderosa pine, studies revealed biological information needed for designing control studies.

For lack of personnel no research is being done on insects attacking wood products. Plans are to assess the research needs and begin work as soon as the project is financed.

Plans for 1963

Plans for 1963 call for completing problem analyses and expanding research on pine bark beetles, continuing studies of balsam woolly aphid predators and ways to integrate biological control with silvicultural control, and continuing chemical-control studies of cone and seed insects.

DEFOLIATORS, REGENERATION, AND RANGE INSECTS

V. M. Carolin, Jr., project leader, W. K. Coulter

Objectives of this Portland headquarters project are to obtain necessary information on the biology and ecology of these insects, to formulate criteria for assessing the need for control, and to develop effective means for preventing or controlling outbreaks by biological, silvicultural, or direct methods.

Principal defoliators studied in 1962 were the spruce budworm and hemlock looper. Among regeneration insects, the European pine shoot moth received major attention. No formal studies have been started on range insects.

Studies on the spruce budworm in southern Washington were principally to improve sampling methods, especially for the egg stage. A control project in the study area ended these investigations. Emphasis was switched to a green form of budworm in southern Oregon to determine its biological characteristics and its relationship to the standard spruce budworm. Renewed study on the hemlock looper sought reliable sampling methods and biological information on the looper and its principal insect parasites.

In a crash program, a 100-percent-effective method of fumigation with methyl bromide against the European pine shoot moth was developed and put to work. Station Research Paper 47 explains the treatment now prescribed in quarantines of Oregon, Washington, and other western States. Fumigation procedures and equipment are described in Station Research Paper 50. These procedures must be followed closely to insure complete kill of the shoot moth with minimum tree damage. Specifications in this publication make it possible to construct portable chambers and apply the fumigant safely and effectively. A special study on modifying standard procedures to obtain greater efficiency in nursery fumigation is yet to be reported.

Plans for 1963

Plans for 1963 are to continue biological and morphological studies of the green budworm, to continue and expand studies of the hemlock looper emphasizing survey techniques for evaluating infestations, and to investigate biological control of the European pine shoot moth.

INSECT DISEASES

Clarence G. Thompson, project leader, Gertraude C. Wittig

This project at the Forestry Sciences Laboratory in Corvallis, Oreg., aims to determine the nature of diseases affecting insects of western forests and browse plants, to study the epizootiology of these diseases, and to develop means of utilizing these insect diseases.

Major efforts during the year were to develop a research program and to plan and develop research facilities for the project. An electron microscope was obtained and installation of it and of supporting special equipment was started late in the year. It will expedite basic studies of insect viruses and their actions.

Laboratory tests with commercial preparations of an entomogenous bacterium, Bacillus thuringiensis Berliner, were conducted against the spruce budworm (green form), black-headed budworm, western hemlock looper, western oak looper, and pandora moth. All five insects were killed in the tests. In a small-scale field test, hemlock looper larvae confined in dacron sleeve cages suffered complete mortality over a 2-week period, indicating that this bacterium may have practical control value against this insect.

Preliminary investigations of the nature of latency in virus-caused diseases of insects did not produce measurable results. Attempts to induce latent infections through exposure to sublethal doses of virus did not give conclusive results. Attempts to obtain generation-to-generation transmission of a virus through the insect egg likewise were inconclusive.

A polyhedrosis virus, that in its natural state sometimes causes significant kill of the hemlock looper and the oak looper, was studied. In field tests this virus required 4 to 6 weeks to kill. A granulosis virus in the green form of the spruce budworm did not play a significant role in 1962 in the natural control of an outbreak of this insect near Lakeview, Oreg.

A nematode, Neoaplectana sp., readily killed the Douglas-fir beetle when applied directly to the beetle in the laboratory. Means of getting the nematode to invade the beetle galleries when applied to the surface of infested logs were investigated without success.

Plans for 1963

In the coming year, basic studies of viruses will dominate the project. Field testing of Bacillus thuringiensis will be expanded, and studies of nematodes and other insect pathogens will be continued in a limited way.

BIOLOGICAL CONTROL OF INSECTS

R. B. Ryan, project leader

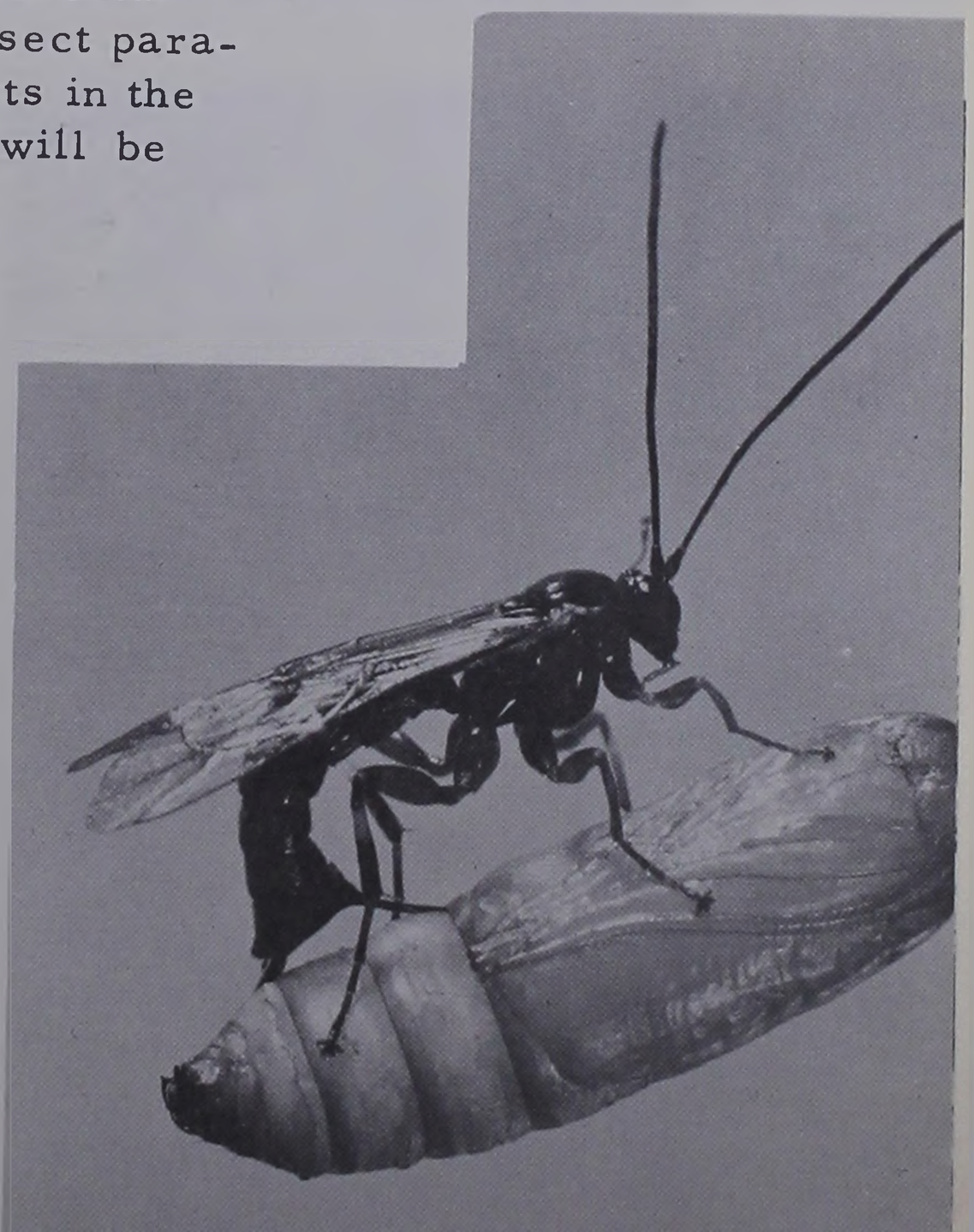
Objectives of this project, headquartered at the Forestry Sciences Laboratory in Corvallis, Oreg., are to determine the factors affecting the abundance and effectiveness of biological control agents, other than pathogens, and to develop means for using these agents to reduce damage by forest and range insect pests.

The effects of light and temperature upon the seasonal activity of Coeloides brunneri Vier., an important native insect parasite of the Douglas-fir beetle, were studied. Both day length and temperature were found significant in the life process that determines whether the development of an individual is arrested (diapause) or uninterrupted. Long days and high temperatures favor continued development, while short days and low temperatures favor the onset of diapause. Photoperiod was shown to act upon the adult female causing her progeny either to undergo or to forgo diapause as mature larvae, depending on the day length she experienced prior to egg deposition.

Methods of efficient laboratory propagation of several parasites were investigated. Eggs of Coeloides brunneri can be obtained in quantity by inducing females to oviposit through balsa wood. Several parasites of forest defoliators, including Itoplectis 4-cingulatus (Prov.) and Apechthis ontario (Cress.), can be successfully reared using, as host, pupae of the greater wax moth Galleria mellonella (L.), an insect which is easily reared in the laboratory.

Plans for 1963

Research will be continued on the developmental requirements of Coeloides brunneri and other insect parasites and on methods of mass rearing such insects in the laboratory. Competition among parasites also will be studied.



Apechthis ontario *laying egg in pupa of greater wax moth.*

PHYSIOLOGY OF INSECTS

F. H. Schmidt, project leader

Objectives of this project at the Forestry Sciences Laboratory in Corvallis, Oreg., are to obtain information needed for an understanding of the vital functions and behavior of western forest and range insects, and to identify and characterize vulnerable steps in their physiology and biochemistry that might be used to increase the efficiency and economy of controlling them.

The specialist who was recruited in the closing days of 1961 to activate this basic project was assigned to the Portland staff for project planning pending completion of the Forestry Sciences Laboratory in Corvallis. Laboratory equipment was ordered and some installed. A start was made on defining physiological characteristics of the green and standard forms of spruce budworm.

Plans for 1963

Plans are to complete the programing of research in the physiology and biochemistry of western forest insects and to make priority studies.

Range, Wildlife Habitat, and Recreation Research

DAVID F. COSTELLO, Division Chief

WILDERNESS RECREATION DYNAMICS

Wiley D. Wenger, Jr., project leader, William R. Burch, Jr.

Current studies are aimed at developing new basic knowledge about the key characteristics and experiences of wilderness users and the values that arise from wilderness recreation. This knowledge is immediately useful for resource managers who want maximum values from recreation on present wilderness areas; also, it leads to better allocation of land for wilderness.

We continued development of practical and statistically sound methods for describing the characteristics of wilderness use. These methods center about unmanned registration stations which are placed on all trails into the Three Sisters Wilderness and Mountain Lakes Wild Areas. This year we tested methods for adjusting data from stations to correct for the persons who do not register. The methods tested and compared involve (1) personal interviews according to a carefully devised sampling plan, (2) license plate data from vehicles parked at trailheads, and (3) records from mechanical trail counters and photographic equipment. Guidelines for the effective use of unmanned registration stations will be issued in the near future.

We are studying some of the variables that are associated with choice, commitment, and persistence in easy-access versus wilderness camping. Social variables being examined include socio-economic class, religion, education, parental leisure patterns, and family size. Findings could lead to the identification of persistent user groups and to greatly refined user predictions and improved planning. Sample selection has been

Unmanned registration stations are being used to obtain basic information about wilderness use.

made through use of campground interviewing and unmanned wilderness registration stations. Final data collection awaits Budget Bureau clearance of a detailed mail questionnaire.

Cumbersomeness of questionnaire clearance procedures has prompted a closer look at the potential use of systematic observation techniques for collection of data. Two observation schedules were developed and field tested on an extensive sample of campgrounds. Study conclusions, when published, will discuss (1) the advantages and limitations of the methods of systematic observation in gathering useful information about recreationists and (2) implications of the behavior patterns in campgrounds for present management and for further research.

Plans for 1963

During 1963, we hope to complete the reports of our initial studies on unmanned registration stations. We also plan to complete data collection and analysis in our exploratory study comparing easy-access campers with wilderness campers. In addition, we will begin reconnaissance and planning work preparatory to studying the use of another Pacific Northwest wilderness area.

RANGE ECOLOGY AND MANAGEMENT

George A. Garrison, project leader, Gerald S. Strickler, Jon Skovlin

Phases of the range ecology and management project receiving study this year were grazing management, range trend, vegetation measurement techniques, and interrelation of timber and forage production. Two of these studies were completed and terminated except for publication of the results.

Grazing Management

The grazing management study of systems and intensities of grazing is in its seventh year. In the vegetation phase of the experiment, changes in forage production are just beginning to appear. Completion of pending analysis should establish trends in response of forage species to the various grazing treatments.

Measuring Range Trends

Study of trend in range condition, as followed by use of loop transects, indicates that the transect method is apparently

The "loop hit" method of recording vegetation cover is useful in measuring range trends and is sensitive to weather effects on range plants.

sensitive to weather effects on vegetation. It must be remembered, however, that effects of weather can be confused with effects of management unless records of weather, management changes, and grazing use are maintained to aid in interpretation of transect data.

Measurement Technique

The measurement technique study of species frequency and density showed that when sampling is confined to study of a single species population, plant density measurements are practical and of value in autecological studies. This research technique has enabled us to determine the best number of plots, ratio of subplots to plots, size of subplots for both forested and nonforested communities, and shape of subplots.

Cattle Distribution

Cattle distribution problems were explained to stockmen attending a Washington State University short course. In summarizing some findings from the Starkey grazing management study, it was pointed out that:

1. Fencing is one of the best ways to control season of grazing and the rationing of forage.

2. Development of water facilities by a variety of techniques can open up new feeding areas.

3. Salt placement is useful in extending or curtailing livestock distribution.

4. Construction of access trails is important in rough topography or timbered areas.

5. Range riding has many important aspects and serves to integrate various management practices.

Cattle Weight

Cattle weight studies of the response of cows and calves to the drop in forage condition in late summer should alert ranchers to the risk in holding cattle on summer range into the fall period. During dry years, cows and calves on mountain rangelands in eastern Oregon are not able to maintain summer gains into fall months. To avoid late summer and fall losses, the rancher should consider marketing his cattle early, giving supplemental feed, or moving the cattle to more nutritious pastures.

Plans for 1963

In the coming year it is planned to complete a preliminary analysis of the cattle management study to determine vegetation and cattle weight trends over the entire elapsed time of the study for purposes of a program review, and plan adjustments in the program as found necessary; continue supervision of National Forest Administration's preparation of range condition standards; plan and initiate intensive soil-vegetation investigation; and assist in planning of a new office-laboratory.

BIG-GAME HABITAT

J. G. Smith, project leader, B. R. McConnell, J. E. Dealy

The objective of our wildlife habitat research project is to provide a scientific basis for more effective management of wildlife habitat in Oregon and Washington. In 1963 our project headquarters will be established at La Grande, Oreg., with satellites at Bend, Oreg., and Wenatchee, Wash. For convenience, our studies are oriented under two broad phases: (1) ecology and physiology of wildlife habitat and (2) wildlife habitat, livestock, and forest management interactions.

Ecology and Physiology of Wildlife Habitat

Spatial distribution of deer pellet groups.--The determination that pellet groups are distributed in random fashion has important management and research implications because it means that pellet group density can be estimated directly from frequency, thereby saving much field time and eliminating counting errors in sampling. We are using the variance-to-mean ratio test for departure from randomness and are comparing our observed frequencies with theoretical frequencies computed for the Poisson series.

Ecological distribution of important big-game forage species.--Our initial efforts are concerned with curlleaf mountain mahogany in central and southeastern Oregon. Our primary data include stand characteristics of the species and site characteristics of ecosystems in which it occurs.

Wildlife Habitat, Livestock, and Forest Management Interactions

Methow pine litter and forage-production study.--To determine the effect of pine needle litter on emergence and survival of understory vegetation under dense stands of ponderosa reproduction, we set up a randomized block experiment, in which we planted orchardgrass seed in October 1961, using the following treatments: (1) litter removed to expose soil surface, seed broadcast, subsequent litter accumulation removed each spring; (2) same as treatment 1, except subsequent litter fall was allowed to accumulate; (3) same as treatment 1,

except that litter removed to expose soil surface was replaced after seed was planted and subsequent litter fall was allowed to accumulate; and (4) seed broadcast on undisturbed litter and subsequent litter fall allowed to accumulate. Seedling counts will be used to evaluate treatment effects.

Typical block of four 3– by 3–foot plots used in litter study showing appearance following treatments explained in text.

Pringle Falls spacing-growth increment and forage-production study.--Our objective here is to determine response, in terms of both amount and chemical content, of understory vegetation to different spacings of ponderosa pine and lodgepole pine. We feel that silvicultural practices which benefit wood production may also benefit wildlife habitat.

Plans for 1963

We will continue to maintain current studies requiring more time for evaluation; terminate and publish portions of longer studies and completed short-term studies that offer useful information; and develop additional studies in response to the current need for wildlife habitat management information. Our main emphasis will be towards utilizing our new headquarters in eastern Oregon at La Grande.

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ADDENDUM

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